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WINNIPEG, MANITOBA

MAN. 21

RURAL ARENA RETROFIT

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MAY 1985

MANITOBA/CANADA CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

The availability of secure and affordable energy supplies is a subject of national concern. It is an accepted fact that our primary energy sources — oil and natural gas — are becoming less accessible and more costly. However, Canada is well-endowed with renewable and alternative resources that can provide a bridge into the future.

To this end, the governments of Manitoba and Canada entered into a Conservation and Renewable Energy Demonstration Agreement which was signed May 9, 1980 and terminated March 31, 1984. The Agreement was dedicated to the development and demonstration of conservation and renewable energy technologies. Equally cost-shared by the provincial and federal governments, the program had a total budget of $18-million.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies, which, when widely adopted, will exploit renewable resources, conserve energy and/or use energy more efficiently.
- To develop broad public awareness of the potential of renewable energy and conservation technology.
- To provide opportunities for the commercial application of the technologies within Manitoba.
- To create economic spin-off benefits for manufacturing, industry and commerce.
- To create employment in new or existing energy-related industries.

Opinions contained in this report are those of the author(s) and are not necessarily those of the Manitoba Department of Energy and Mines, or Energy, Mines and Resources Canada.

Use of company names, brand names or trademarks is made for informational purposes only and does not constitute endorsement or recommendation over similar products or services.

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EXECUTIVE SUMMARY

1. EXECUTIVE SUMMARY

In January 1983, Scouten Mitchell Sigurdson and Associates Limited were commissioned by the Province of Manitoba to conduct an Energy Retrofit Program on six rural recreation facilities in Manitoba. The six facilities studied were:

Lorette Sports Centre	Lorette, Manitoba
Roy H. Johnston Arena	The Pas, Manitoba
Stonewall Arena	Stonewall, Manitoba
Yellowhead Centre	Neepawa, Manitoba
Roblin & District Arena	Roblin, Manitoba
Carman Community Arena	Carman, Manitoba

The program, which came to be known as the "Arena Retrofit Program", had as its purposes the following:

.1 provide technical and financial assistance to six rural arenas in Manitoba who were prepared to implement and demonstrate energy conserving technologies.

.2 prove the reliability and cost effectiveness of retrofit for energy conservation.

.3 develop public awareness and understanding of energy retrofit potential so it becomes generally accepted and widely adopted throughout Manitoba.

With the completion of seminars in early March, 1984, it is the opinion of the writer that the program was successful in fulfilling all of its objectives.

The retrofit costs and savings are summarized in the following table:

TABLE 1

Facility	Estimated Cost of Recommended Options $	Actual Cost * Implemented Options	Estimated Energy Savings (kWh)	Estimated Cost Savings ($)	Estimated Simple Payback (Yr.)
Lorette	46,745	55,683	141,455	6,735	8.3
Roy H. Johnston (The Pas)	58,900	60,000	327,232	13,506	4.4
Stonewall	54,370	30,945	125,222	4,945	6.3
Yellowhead Centre (Neepawa)	45,125	50,750	184,167	4,764	10.7
Roblin	30,030	57,439	146,666	7,946	7.2
Carman	60,000	60,000	439,722	10,530	5.7
TOTALS	303,170	314,817*	1,364,464	48,426	6.5

* Actual cost figures reflect deletion of some recommended retrofit options as well as variations between tendered and estimated costs. In addition, work beyond that recommended by the Consultants was done directly by each arena, for additional total costs estimated to be approximately $110,000.00.

Actual energy and cost savings data will be provided in a future report to be issued after a one year monitoring period.

SOMMAIRE

En janvier 1983, la société Scouten Mitchell Sigurdson and Associates Limited a été engagée par le Manitoba pour effectuer une étude d'amélioration énergétique dans les six établissements ruraux de loisirs énumérés ci-après:

Lorette Sports Centre	Lorette
Roy H. Johnston Arena	Le Pas
Stonewall Arena	Stonewall
Yellowhead Centre	Neepawa
Roblin & District Arena	Roblin
Carman Community Arena	Carman

L'objet du projet, baptisé Programme d'amélioration des patinoires (Arena Retrofit Program), était le suivant:

.1 Fournir une aide technique et financière à six patinoires rurales du Manitoba où il y avait une volonté de mettre en oeuvre et de démontrer le bien-fondé des techniques d'économie d'énergie.

.2 Démontrer la fiabilité et la rentabilité des mesures d'amélioration énergétique.

.3 Sensibiliser le public aux possibilités qu'offre l'amélioration énergétique afin de favoriser l'acceptation et l'adoption généralisées des mesures proposées.

À l'issue de la série de colloques tenus au début mars 1984, l'auteur du présent rapport estime que tous les objectifs visés par le programme ont été réalisés.

Les coûts des travaux d'amélioration énergétique et les économies ainsi réalisées sont exposés dans le tableau suivant:

TABLEAU I

Établissement	Coût estim. des options recommandées ($)	Coût réel* des options adoptées ($)	Économies énergét. estimées (kWh)	Économies prévues ($)	Délais de réc. pré. (simple) (année)
Lorette	46 745	55 683	141 455	6 735	8,3
Roy H. Johnston (Le Pas)	58 900	60 000	327 232	13 506	4,4
Stonewall	54 370	30 945	125 222	4 945	6,3
Yellowhead Centre (Neepawa)	45 125	50 750	184 167	4 764	10,7
Roblin	30 030	57 439	146 666	7 946	7,2
Carman	60 000	60 000	439 722	10 530	5,7
TOTAUX	303 170	314 817*	1 364 464	48 426	6,5

* Dans les coûts réels, il faut tenir compte de l'élimination de certaines améliorations recommandées ainsi que des variations entre les coûts cités dans la soumission et les coûts estimés. Par ailleurs, des

travaux autres que ceux recommandés par l'expert-conseil ont été effectués par les responsables des patinoires. On estime ces coûts supplémentaires à environ 110 000 $.

Les données se rapportant aux économies réalisées sur le plan énergétique et sur le plan financier seront fournies dans un autre rapport qui sera publié à l'issue de la première année d'exploitation.

INTRODUCTION

2. INTRODUCTION

The information contained in this report is intended to provide the reader with a general understanding of the potential for Energy Conservation in rural recreation facilities. Reference is made to individual Energy Analysis Studies and Seminar Manuals in the body of this report. It is highly recommended that the referenced material is reviewed prior to commencement of a retrofit program.

The Arena Retrofit Program was conducted in five stages.

The first stage was to examine each arena and prepare an energy analysis study, which identified energy retrofit projects based on an analysis of design and operating conditions, energy and cost savings, capital costs and simple payback periods. Recommendations were examined under three main headings - Building, Mechanical Systems and Electrical Systems. Under each heading retrofit options were categorized under the subheadings of No Cost and Low Cost, Medium Cost and High Cost.

The second stage was a review of the report by representatives of Energy and Mines, the Town and the consultant. Selection of the options to be implemented was then decided upon.

The third stage involved implementation of the selected options, with the major work carried out under contract with the Town in accordance with documents prepared by the consultant. Other portions of work were administered by the arena with guidance from the consultant.

The fourth stage was preparation of this final report entitled "Energy Conservation Retrofit in Rural Recreation Facilities".

The fifth stage was to conduct seminars in selected regions. The seminars were conducted by the consultant. A seminar manual was prepared for distribution at the seminars. Copies of the seminar manual are available upon request from Manitoba Energy and Mines.

2.1 Retrofit Options

Retrofit options are presented on the following pages.

Each arena was studied in detail in order to arrive at a site specific retrofit program. Arenas can, in many ways, be treated as 'typical'; however, there are also retrofit options which are unique to each facility. The retrofit options presented herein are a summary of those recommended for the six facilities studied. Operators of other arenas may use this report as a guideline, with the caution that not all recommendations will apply to their facilities.

Ranges given for costs and payback periods are intended to give a general indication only and can vary considerably from facility to facility. Arena operators should have their arenas carefully analysed by competent individuals prior to implementation of any costly retrofit measures.

Appendix C "Manufacturers Information" includes information on various equipment utilized in the retrofit program.

TABLE 2

Architectural Options

		Cost Range ($)	Range of Payback Period (Years)	Comments
1.	Improve, repair or replace weatherstripping and sealing at doors, windows and the building openings.	1,500 to 2,500	1.5 to 6	Excellent energy retrofit, annual checks and repairs are required to ensure continuing savings.
2.	Replace existing uninsulated doors in poor condition with new insulated steel doors - heated areas only.	400 +	14 +	When consideration is being given to replacing doors, good quality insulated doors should be installed.
3.	Add insulation to building walls, ceilings, etc.	500 +	3 +	Payback range is dependent upon level of existing insulation, cost depends on area to be insulated.
4.	Replace single glazed windows with double glazed.	500 +	20 +	Payback periods do not warrant replacement. However, when upgrading - double glazed should be used.
5.	Replace windows with insulated in-fill panels.	100 +	5 +	Usually a good investment when windows are not required for daylight contribution.

6. Operating Procedures - Refer to Section 3.2 of this report.

TABLE 3

Mechanical Options

		Cost ($)	Range of Payback Period (Years)	Comments
1.	Heat recovery from arena ice plant for ice flood water heating.	5,000 to 10,000	5 to 10	Excellent application
2.	Heat recovery from arena ice plant for building heating	30,000 +	5 +	Arena must be heated before this is considered, or heating must be added before heat recovery is practical.
3.	Heat recovery from curling rink ice plant for building heating	30,000 +	2 to 6 +	Excellent potential in heated curling rinks.
4.	Install timer to control washroom exhaust fan, wire into washroom light switch.	200 +	2 +	Depends on number of fans.
5.	Install locking cover over thermostat.	20 +		Payback period should be approximately 1 year.
6.	Installation of updraft fans in curling rink.	1,000 to 2,000		Payback periods in terms of energy cost reduction are negligible - fans are used to reduce moisture and dripping problems.
7.	Installation of updraft fans in arena.	3,000 to 6,000		
8.	Repair or replace backdraft dampers for exhaust fans and ensure a tight seal on closing.	200 to 500	2 +	
9.	Install good sealing dampers on make-up air to ice area.	500 to 2,500	1 +	This is especially important in heated rinks - to prevent leakage of outdoor air which must be heated.

Mechanical Options (Continued)

	Cost ($)	Range of Payback Period (Years)	Comments
10. Install night thermostat - to allow setback of temperatures at night.	100 +	1 +	Depends on number and type of thermostats, type of heating system.
11. Install insulated covers over wall exhausters in low use areas.	250 +	6 +	Depends on number of fans.

12. Operating Procedures - Refer to 3.2.

TABLE 4

Electrical Options

		Cost ($)	Range of Payback Period (Years)	Comments
1.	Replace incandescent lighting with fluorescent in lobbies and waiting areas, change - rooms, etc.	500 +	2 +	Cost depends on number of fixtures, ease of installation. Payback period depends on light levels required (i.e. if light level is very high, then less fixtures are required and better payback results.)
2.	Replace incandescent lighting in curling rink with fluorescent.	2,500 +	6 +	Cost shown is for 3 sheet rink. Payback should not vary much for larger rinks.
3.	Convert arena lighting from incandescent to metal halide.	14,000 +	6 +	Cost shown could vary depending on rink size. Payback periods should be close to 6 years.
4.	Install power factor correction capacitors on compressors.	1,200 +	1 +	Excellent retrofit option.
5.	Install peak demand limiting devices or demand controller.	2,500 +	2 +	Good potential in buildings which have electric water heaters, electric heating.
6.	Combine electrical services	4,000 +	6 +	Where buildings have more than one service, combining services is sometimes (not always) cost effective.

Electrical Options (Continued)

	Cost ($)	Range of Payback Period (Years)	Comments
7. Redistribute light fixtures.	6,000 Variable	7 +	This applies particularly to arena lighting where too many fixtures poorly distributed can cause shading.

8. Operating Procedures - Refer to section 3.2 of this report.

2.2 Operating Procedures

Changes to procedures for operating the building and its mechanical and electrical systems can result in significant and substantial energy cost savings. Establishing a specific set of operating guidelines in a facility will help ensure continued success in any energy cost reduction program.

As a general guideline, stickers and posters can be obtained, free of charge, from government departments and utilities to remind people to switch off equipment, close doors, etc. whenever possible. It is suggested that all facilities order a supply of these stickers and posters, and make use of them.

Architectural:

.1 Check weatherstripping and fit at doors, windows and other building openings at least once annually - preferably prior to start of winter season.

.2 Create an awareness so that personnel and users will close windows, doors, etc. as a general attempt to reduce energy use.

Mechanical:

.3 When mechanical equipment is not required to operate, it should be switched off.

.4 Exhaust fans in washrooms should be switched off during unoccupied periods.

.5 Advise canteen personnel to operate exhaust fans only as required during occupied periods.

.6 Room thermostats should be set at the lowest temperature possible. During unoccupied periods the temperature should be lowered approximately 6 deg. C below the occupied setting.

.7 Ice flood water temperature should be set at the lowest temperature which will still provide suitable ice while using the same quantity of hot water.

.8 Temperature in normally unoccupied areas such as tractor rooms, storage rooms, compressor rooms should be set to maintain a space temperature just above freezing (say 4 deg. C).

.9 If the compressor room exhaust fan is controlled from a room thermostat (this does not apply for Ammonia Systems) the thermostat should be set at approximately 30 deg. C.

.10 When operating exhaust fans in ice areas, ensure that make up air is provided directly from the outdoors, i.e. drawing air from heated areas is energy wasteful.

.11 Regularly check all plumbing fixtures and equipment for leaks and make necessary repairs immediately

.12 During the summer, if the facility is unoccupied, the gas supply to domestic water heaters, furnace pilot lights and other gas fired equipment should be shut off.

.13 Ice plant operation and maintenance should be done according to a detailed set of instructions. These have been prepared and are presented in the seminar manual (under separate cover).

Electrical:

.14 When electrical equipment is not required, it should be switched off.

.15 Arena staff should be advised to switch off lights in all unoccupied spaces and whenever a space is vacated.

.16 Where possible, lamps can be removed from light fixtures in areas of excess lighting. When this is done, ballasts should also be disconnected.

.17 During the summer, if the facility is unoccupied, the power supply to electrical water heaters should be switched off.

RECREATION CENTRE
RETROFIT SUMMARIES

3. RECREATION CENTRE RETROFIT SUMMARIES

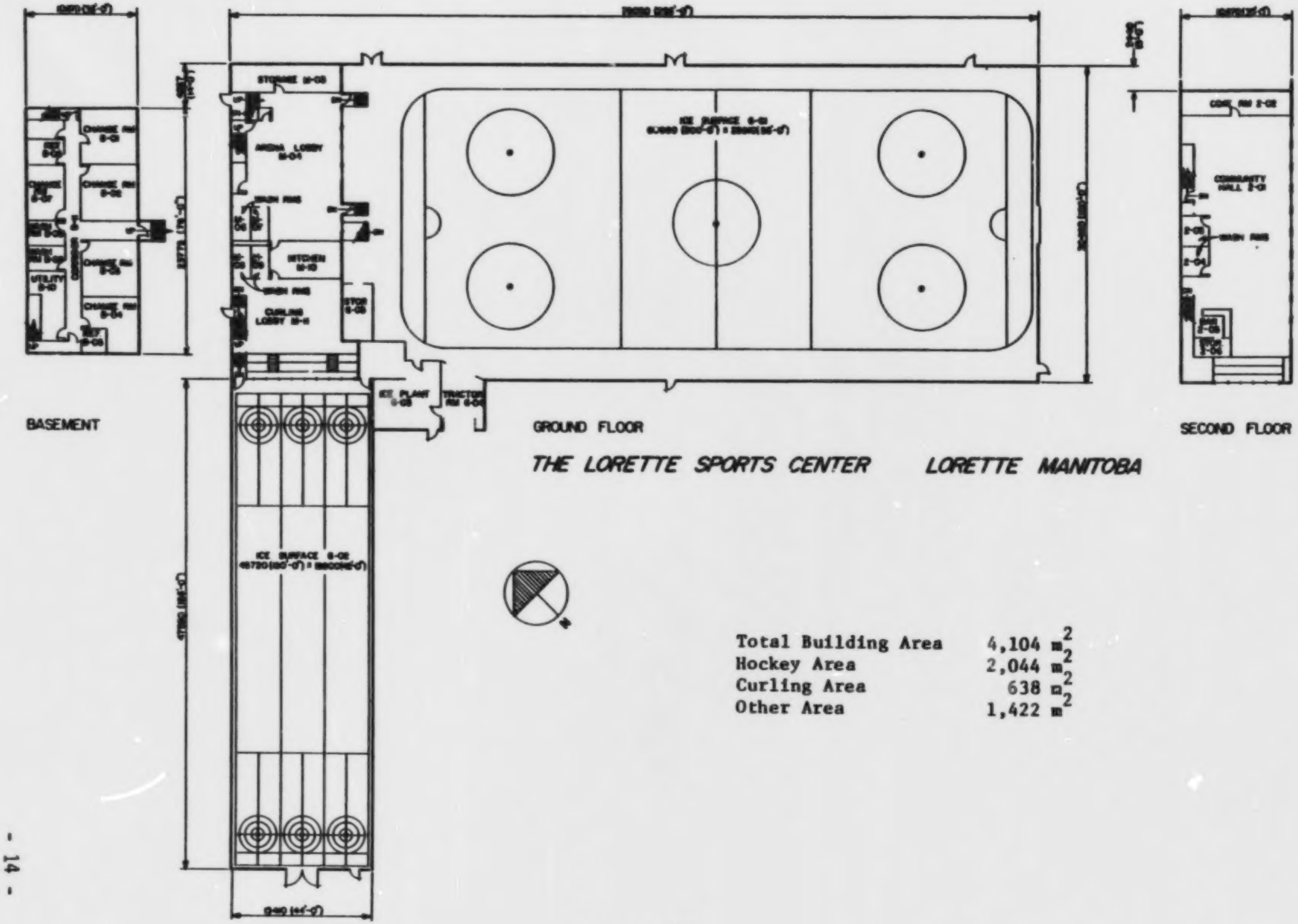
3.1 Lorette Sports Centre

.1 General Description

The Lorette Sports Centre, (Figures 1(a) to 1(f)) constructed in 1964-65, is a combined arena and curling facility of wood frame construction. The building is electrically heated with the exception of the arena, which is unheated. Artificial ice in the curling rink was included at the time of construction. Arena and curling rink ice surfaces have incandescent lighting. Other lighting is a mixture of incandescent and fluorescent. The water system is facility owned and the sewer is provided by the Municipality. The building and its mechanical and electrical systems are generally of 1964 vintage, with the exception of major renovations in 1982, which included upgrading of the arena facility - installation of a new ice plant, insulated concrete floor and new water heaters - and upgrading and remodelling of basement dressing rooms.

.2 Pre-Retrofit Energy Consumption

The pre-retrofit energy consumptions and costs for the Lorette Sports Centre are detailed in Appendix A. The total annual energy consumption (1982) was 546,000 kWh (1,966 GJ) at a cost of $20,628.


BASEMENT
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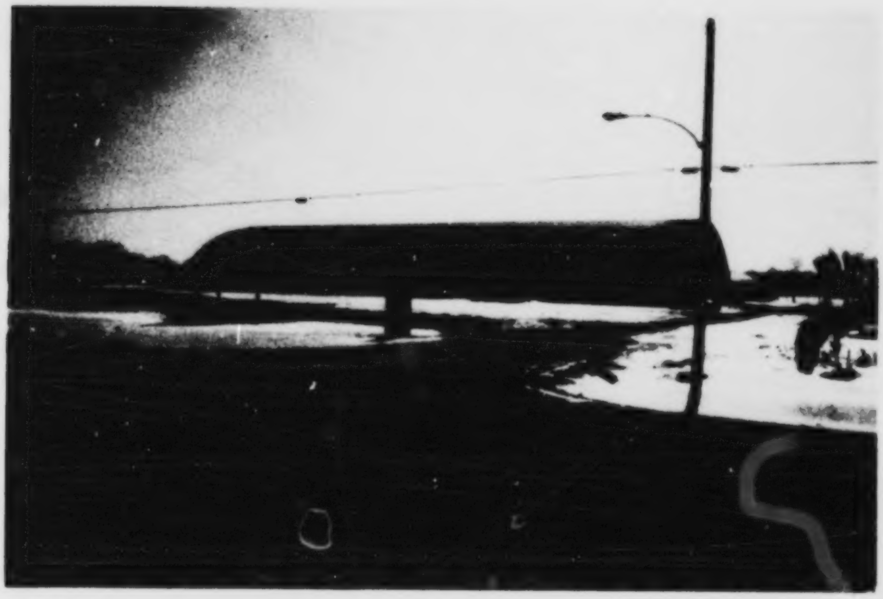
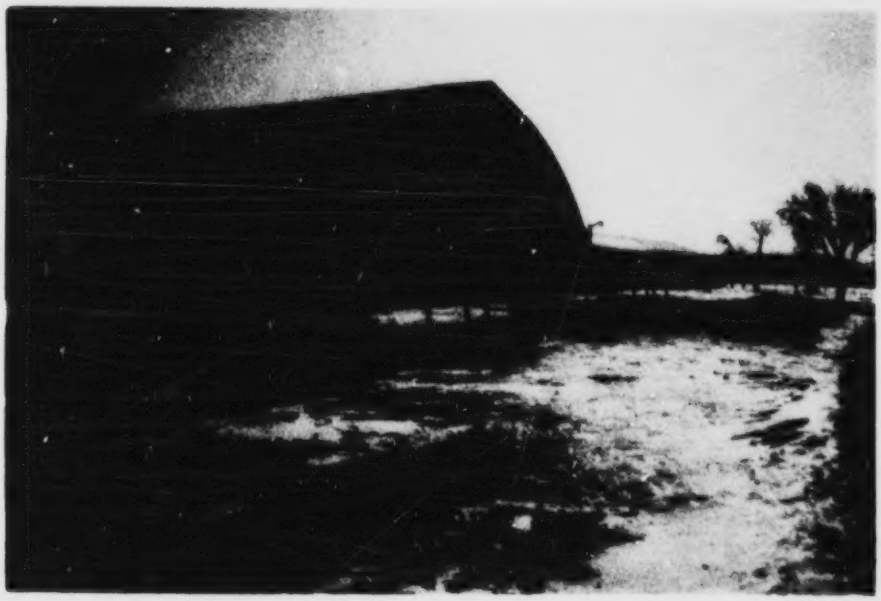
CHANGE RM
CHANGE RM
CHANGE RM
UTILITY
STORAGE
ARENA LOBBY
WASH RMS
KITCHEN
WASH RMS
CURLING LOBBY
STOR
ICE SURFACE
ICE SURFACE
ICE PLANT
TRACTOR RM
GROUND FLOOR
COMMUNITY HALL
WASH RMS
SECOND FLOOR
THE LORETTE SPORTS CENTER LORETTE MANITOBA

Total Building Area	4,104 m^2
Hockey Area	2,044 m^2
Curling Area	638 m^2
Other Area	1,422 m^2

Fig. 1 (a)

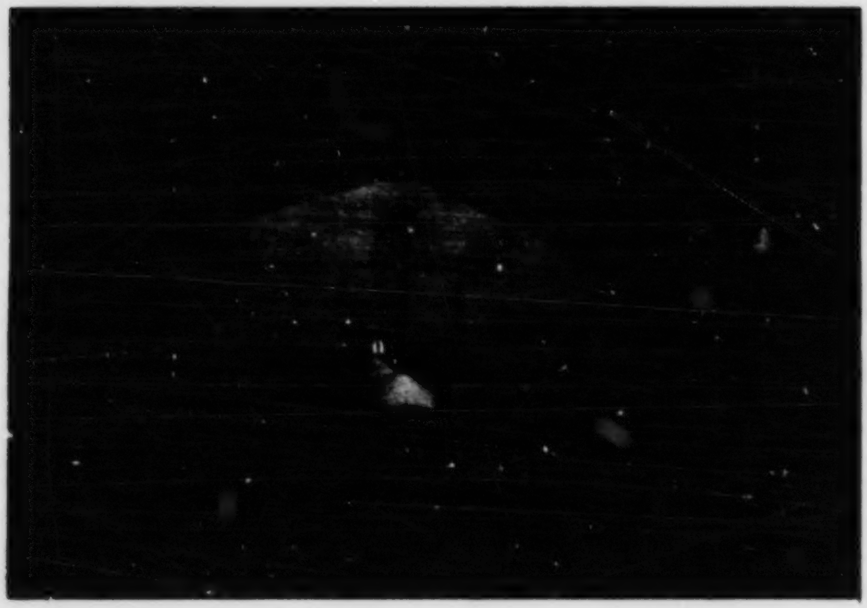


Lorette Sports Centre, view from North.



West Elevation, Arena and Curling Rink.

Arena & Curling Rink, view from South.



South Elevation, Curling Rink.

East Elevation, Arena.

Arena roof at ground level.

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Lorette Sports Centre

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
No Cost and Low Cost				
I * 5.1.1.2 Improve weatherstripping and sealing of building heated areas	500	18,075	233	2
I * 5.1.1.3 Repair Arena ice area and Tractor Room leakage areas, including some re-shingling	500	18,075	233	2
I * 5.1.1.4 Install louvred access door to Curling Rink attic space	200	-	-	-
Medium Cost				
I * 5.1.2.2 Repair and weatherstrip man doors in the Arena	700	7,752	100	7
High Cost				
5.1.3.2 Re-level, re-pipe and insulate Curling Rink floor	25,000	-	-	-
* 5.1.3.3 Replace exterior doors - Central Area	1,950	6,750	115	17

Mechanical Systems

No Cost and Low Cost

I	*	5.2.1.2 Changes to Ice Plant operation	0	1,800	21	Immediate
I	*	5.2.1.3 Maintain minimum ice thickness	0	7,752	100	Immediate
I	*	5.2.1.4 Operate brine pump for Arena in extremely cold weather	0	31,500	406	-
I	*	5.2.1.5 Repair back-draft dampers and install insulated covers for exhaust fans in Community Hall	250	3,380	44	6
I	*	5.2.1.6 Operating guide-line for compressor room exhaust fan	0	-	-	-
I	*	5.2.1.7 Reduce ice flood water temperature	0	3,750	48	Immediate
I	*	5.2.1.8 Reduce temperature in Tractor Room and compressor room	0	-	-	Immediate
I	*	5.2.1.9 Operating guidelines for canteen exhaust fan	0	-	-	Immediate
I	*	5.2.1.10 Operating guideline for hot water tanks	0	-	-	Immediate

I	* 5.2.1.11 Reduce domestic hot water temperature	0	-	-	Immediate
I	* 5.2.1.12 Guideline for monitoring maintenance and checking of mechanical equipment	0	-	-	Immediate
I	* 5.2.1.13 Clean force flow heaters and set back temperature, etc.	0	-	-	Immediate
I	* 5.2.1.14 Guideline for operation of equipment	0	-	-	Immediate
I	* 5.2.1.15 Upgrade housekeeping practices	0	-	-	Immediate
I	* 5.2.1.16 Install updraft ceiling fans in Curling Rink	300	-	-	-
I	* 5.2.1.17 Repair backdraft dampers for Arena exhaust fans	150	-	-	?
Medium Cost					
I	* 5.2.2.2 Replace washroom exhaust fan, etc.	600	-	-	?

I	*	5.2.2.3 Install motorized intake dampers and bird-screen and back-draft dampers on existing exhaust fan in Curling Rink	600	13,200	170	3.5
I	*	5.2.2.4 Modify controls for Arena ice plant	1,000	32,325	417	2.4
I	*	5.2.2.5 Modify controls for Curling Rink ice plant	1,000	8,140	105	9.5
High Cost						
		5.2.3.2				
I	*	- Arena	4,000	27,989	361	11
I	*	- Curling Rink	24,000	156,086	4,649	5.2
		5.2.3.3 Water treatment equipment	-	-	-	-
		5.2.3.4 Arena updraft fans	3,000	-	-	-
Electrical Systems						
No Cost and Low Cost						
I	*	5.3.1.2 Clean main switch and fuses	-	-	-	-
I	*	5.3.1.3 Guideline for maintenance and switching of Arena lighting	300	-	-	?
I	*	5.3.1.4 Guideline for maintenance and switching of curling rink lighting	100	-	-	?

	5.3.1.5 Guideline for maintenance and repair of Community Hall fixtures	50	-	-	?
I *	5.3.1.6 Guideline for light switching in change rooms	-	-	-	Immediate
*	5.3.1.7 Replace dimmer switches in Community Hall	20	-	-	-
	Medium Cost				
*	5.3.2.2 Replace Arena lobby lighting with fluorescent	450	2,680	95	4.7
I *	5.3.2.3 Replace Curling Rink lighting with fluorescent	400	1,270	17	10.9
I	5.3.2.4 Replace Community Hall and other lighting with fluorescent	700 (Community Hall only)	2,636	34	20
	High Cost				
I *	5.3.3.2 Convert Arena lighting to metal halide	14,400	46,674	2,210	6.5
I *	5.3.3.3 Convert Curling Rink lighting to fluorescent	2,625	4,016	362	6.9
I *	5.3.3.4 Convert basement lighting to fluorescent	1,620	3,111	107	15.1

I	* 5.3.3.5 Power factor correction	1,500	-	1,202	1.25
I	* 5.3.3.6 Peak demand limiting	3,000	-	815	3.7
I	* 5.3.3.7 Interlock hot water heating	2,500	-	1,032	2.5

Energy consumption and cost monitoring of the retrofitted facility is in progress. This data will be provided in a future report.

3.2 Roy H. Johnston Arena

.1 General Description

The Roy H. Johnston Arena,(Figures 2(a) to 2(c)) constructed in 1971, is a combined arena and curling facility. The facility consists of two insulated butler type buildings joined end-to-end. It is heated with a combination of propane heat in the central area, and electric heat in the ice areas and mechanical room.

The majority of the lighting in the facility is fluorescent, with some incandescent. Sewer and water are provided by the town. Both the arena and curling rink have artificial ice. The building and its mechanical and electrical systems are generally of 1971 vintage, with the exception of major renovations in 1982, which included:

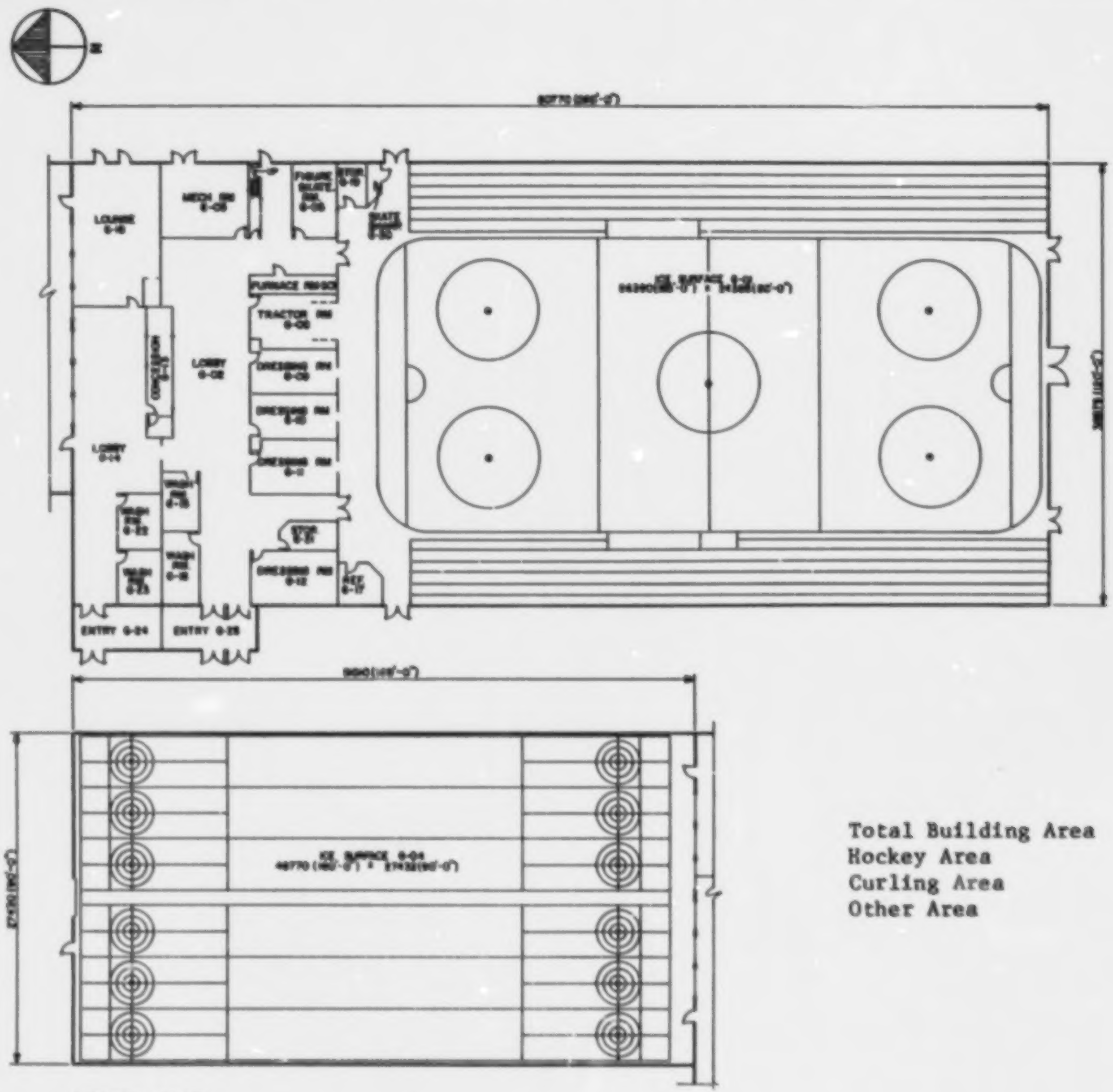
a) replacing the ceiling in the arena central area with the potential for a future second floor,

b) replacing the oil fired heating system in the central area with propane fired equipment, and

c) replacing the electrical domestic hot water heating system with propane fired equipment.

.2 Pre-Retrofit Energy Consumption

The pre-retrofit energy consumptions and costs for the Roy H. Johnston Arena are detailed in Appendix A. The total annual energy consumption (1981) was 1,535,634 kWh (5,528 GJ) at a cost of $49,376.

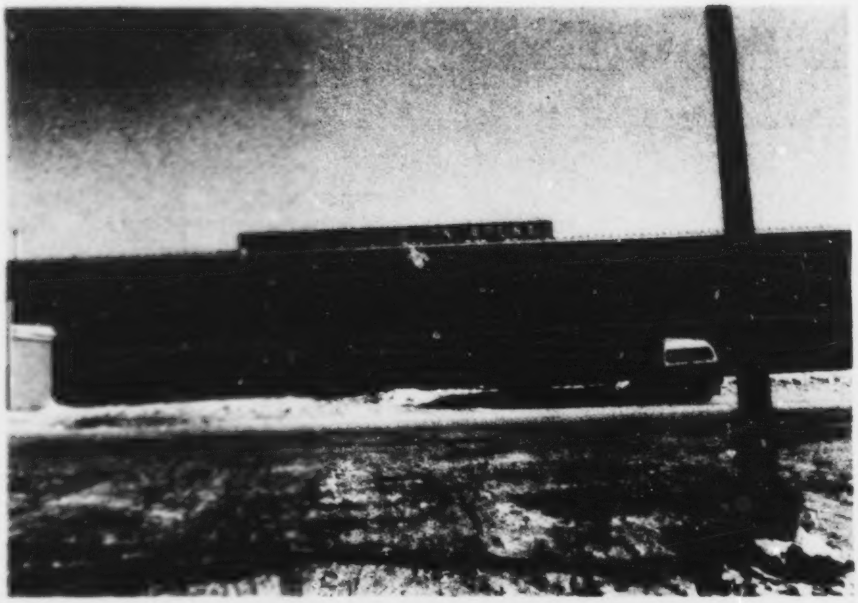

N
LOUNGE
MECH RM
FIGURE SKATE RM
STOR
FURNACE RM
TRACTOR RM
LOBBY
DRESSING RM
DRESSING RM
DRESSING RM
DRESSING RM
CONCESSION
LOBBY
WASH RM
WASH RM
WASH RM
WASH RM
STOR
REF
ENTRY G-24
ENTRY G-25
ICE SURFACE
ICE SURFACE

GROUND FLOOR

ROY H. JOHNSTON ARENA THE PAS MANITOBA

Total Building Area	4,423 m^2
Hockey Area	2,118 m^2
Curling Area	1,413 m^2
Other Area	892 m^2

Fig. 2 (a)



Roy H. Johnston Arena, View From West

Roy H. Johnston Arena, View From North-West

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Roy H. Johnston Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
No Cost and Low Cost				
I * 5.1.1.2 Improve weatherstripping and sealing of building openings	1,500	84,659	2,930	0.5
I * 5.1.1.3 Monitor second floor/attic space for potential moisture problems	-	-	-	-
I * 5.1.1.4 Blank off, seal and insulate roof vents in Curling Rink	300	-	-	?
I * 5.1.1.5 Repair and re-tape insulation in Arena and Curling Rink	500	-	-	?
Medium Cost				
5.1.2.2 Replace interior doors at main entrance to Curling Rink	2,000	-	-	?
High Cost				
I * 5.1.3.3 Insulate wall between central area and arena ice area	4,000 to 5,000	7,440	320	12 - 16

Mechanical Systems

No Cost and Low Cost

I	* 5.2.1.2 Changes to Ice Plant operation	0	-	-	Immediate
I	* 5.2.1.3 Maintain minimum ice thickness	0	-	-	Immediate
I	* 5.2.1.4 Reduce ice flood water temperature	0	5,344	230	Immediate
I	* 5.2.1.5 Operating guideline for compressor room unit heater	0	-	-	Immediate
I	* 5.2.1.6 Operating guidelines for canteen exhaust fan	0	-	-	Immediate
I	* 5.2.1.7 Guideline for monitoring maintenance and checking of mechanical equipment	0	-	-	Immediate
I	* 5.2.1.8 Guideline for operation of equipment	0	-	-	Immediate
I	* 5.2.1.9 Upgrade housekeeping practices	0	-	-	Immediate
I	* 5.2.1.10 Guideline for operation of Curling Rink ventilation	0	-	-	Immediate
I	* 5.2.1.11 Remove cardboard from Curling Rink unit heaters	0	-	-	Immediate

I	* 5.2.1.12 Guidelines for manual operation of Arena heating	0	-	-	Immediate
I	* 5.2.1.13 Switch off vestibule heaters	0	-	-	Immediate
I	* 5.2.1.14 Reduce hot air supplied to Tractor Room	0	-	-	Immediate
I	* 5.2.1.15 Guideline for operation of Curling Rink downdraft fans	0	-	-	Immediate
I	* 5.2.1.16 Replace downdraft fans in Curling Rink with updraft fans	500	-	-	-
I	* 5.2.1.17 Install night thermostat for furnace	100	2,651	114	1.0
I	* 5.2.1.18 Install night thermostats for ice plants	400	6,202	80	5.0
Medium Cost					
I	* 5.2.2.2 Install night set back thermostats for unit heaters (gas fired)	600	3,326	143	6
I	* 5.2.2.3 Install time clock and night setback 'stat' in Curling Rink. Relocate existing thermostats	500	4,884	63	8

I	*	5.2.2.4 Upgrade existing cooling tower - cooling tower repairman	?	-	-	-
	*	5.2.2.5 Investigate the possibility of dumping snow shaved from Arena ice surface outdoors	?	-	-	?
I	*	5.2.2.6 Install motorized dampers in Arena make-up air openings	2,300	-	-	5 - 10
I	*	5.2.2.7 Install motorized dampers in Curling Rink make-up air openings	1,000	50,465	651	1.5
High Cost						
I	*	5.2.3.2 Heat Recovery from Ice Plant				
		- Curling Rink	31,000	451,092	13,400	2.3
		- Arena	6,500	32,430	1,400	4.6
		5.2.2.3 Water treatment equipment	-	-	-	-
		5.2.3.4 Arena updraft fans	4,000	-	-	-

Electrical Systems

No Cost and Low Cost

I		5.3.1.2 Guideline for switching of Arena lighting	0	-	-	Immediate
I		5.3.1.3 Guideline for switching of change room and dressing room lighting	0	-	-	Immediate
I		5.3.1.4 Guideline for switching lobby lighting	0	-	-	Immediate
I	*	5.3.1.5 Guideline for light switching in curling rink	0	-	-	Immediate
I	*	5.3.1.6 Guideline for lighting maintenance	0	-	-	Immediate

Medium Cost

I	*	5.3.2.1.1 Reduce Arena light fixtures	700	12,790	514	1.4
I	*	5.3.2.1.2 Reduce Curling Rink lighting				
		- by removing fixtures	3,000	12,390	662	4.5
		- by removing lamps and ballasts	1,000	12,390	662	1.5
I	*	5.3.2.1.3 Reduce Arena lobby light fixtures	675	8,088	325	2.1
I	*	5.3.2.1.4 Reduce Curling Rink lounge light fixtures	300	2,010	107	2.8

I	* 5.3.2.1.5 Reduce lighting in Lobby G-14	600	3,600	207	3.0
	* 5.3.2.1.6 Replace washroom light fixtures	300	940	50	6.0
I	* 5.3.2.1.7 Power factor correction	2,500	-	1,535	1.6

Energy consumption and cost monitoring of the retrofitted facility is in progress. This data will be provided in a future report.

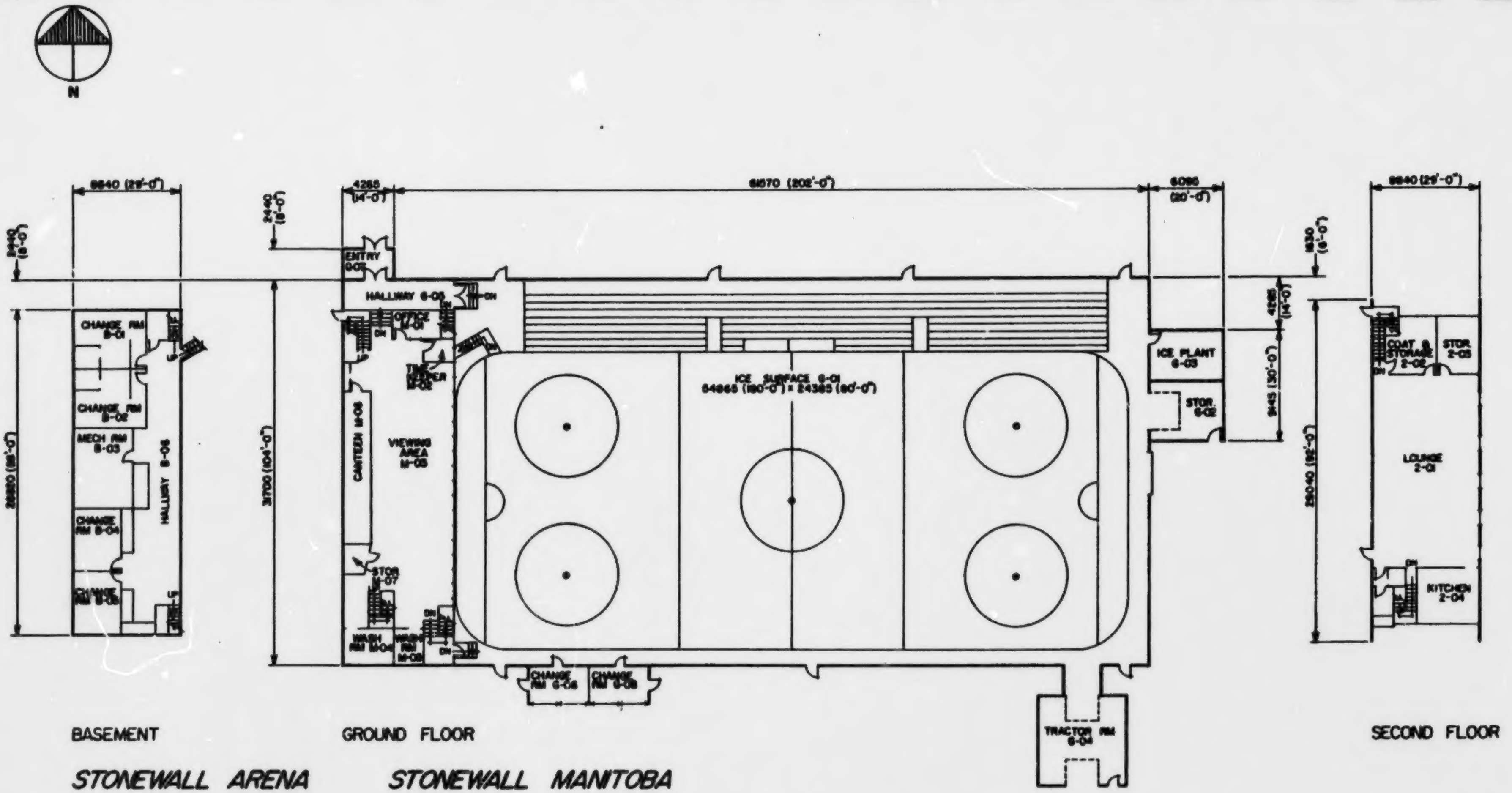
3.3 Stonewall Arena

.1 General Description

The Stonewall Arena, (Figures 3(a) to 3(i)) constructed in 1961, is a recreation facility of wood frame construction. The building is heated by natural gas and electricity, with the exception of the arena which is unheated. Lighting in the arena ice area is mercury vapour with some incandescent. Lighting in the remainder of the building is a mixture of fluorescent and incandescent. The water supply and sewer systems are facility owned. The building and its mechanical and electrical systems are generally of 1961 vintage, with the exception of major renovations in 1970, 1980, 1981 and 1982. Included in these renovations are the installation of an ice plant and concrete rink floor, change rooms, tractor room, new brine header and second floor hall renovations.

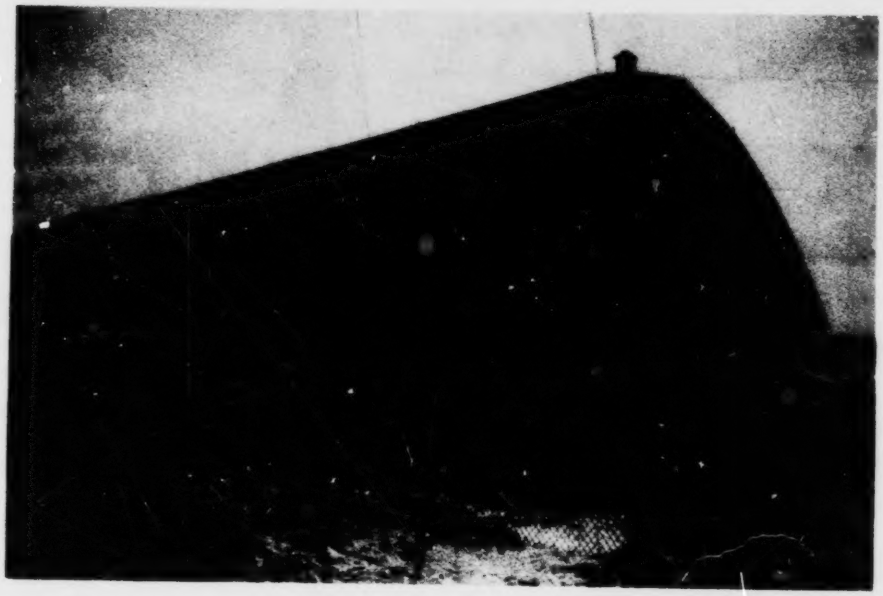
.2 Pre-Retrofit Energy Consumption

Pre-retrofit energy consumptions and costs for the Stonewall Arena are detailed in Appendix A. The total annual energy consumption (1982) was 560,917 kWh (2019 GJ) at a cost of $14,973.


N
8840 (29'-0")
2440 (8'-0")
28880 (95'-0")
CHANGE RM B-01
CHANGE RM B-02
MECH RM B-03
CHANGE RM B-04
CHANGE RM B-05
HALLWAY B-06
4265 (14'-0")
61570 (202'-0")
6095 (20'-0")
31700 (104'-0")
ENTRY G-07
HALLWAY G-05
OFFICE M-01
TIME KEEPER M-02
CANTEEN M-06
VIEWING AREA M-05
STOR M-07
WASH RM M-04
WASH RM M-03
ICE SURFACE G-01
54865 (180'-0") x 24385 (80'-0")
CHANGE RM G-06
CHANGE RM G-08
ICE PLANT G-03
STOR. G-02
TRACTOR RM G-04
1830 (6'-0")
4265 (14'-0")
9145 (30'-0")
29040 (95'-0")
COAT & STORAGE 2-02
STOR 2-05
LOUNGE 2-01
KITCHEN 2-04
DN
UP
BASEMENT
GROUND FLOOR
SECOND FLOOR
STONEWALL ARENA
STONEWALL MANITOBA

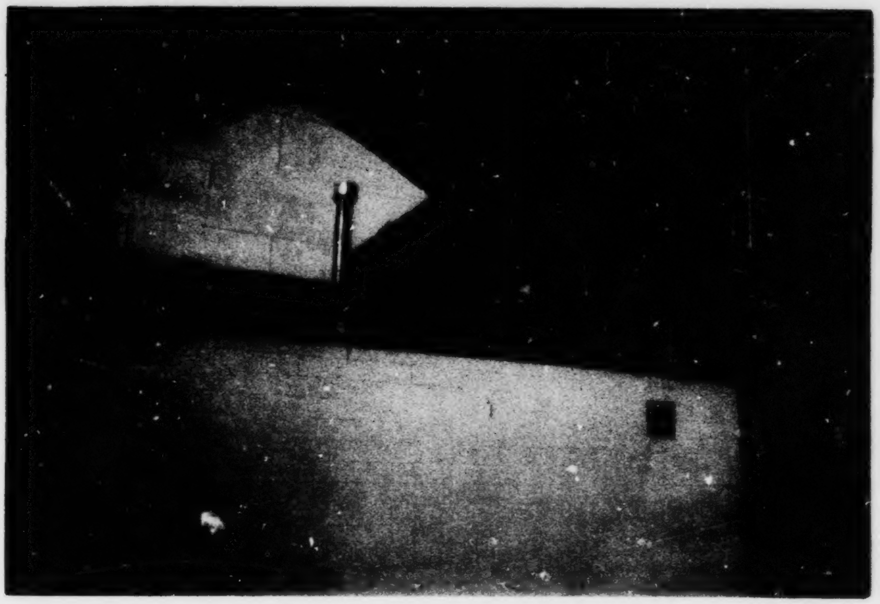
Total Building Area	2,726 m^2
Hockey Area	1,807 m^2
Other Area	919 m^2

Fig. 3 (a)

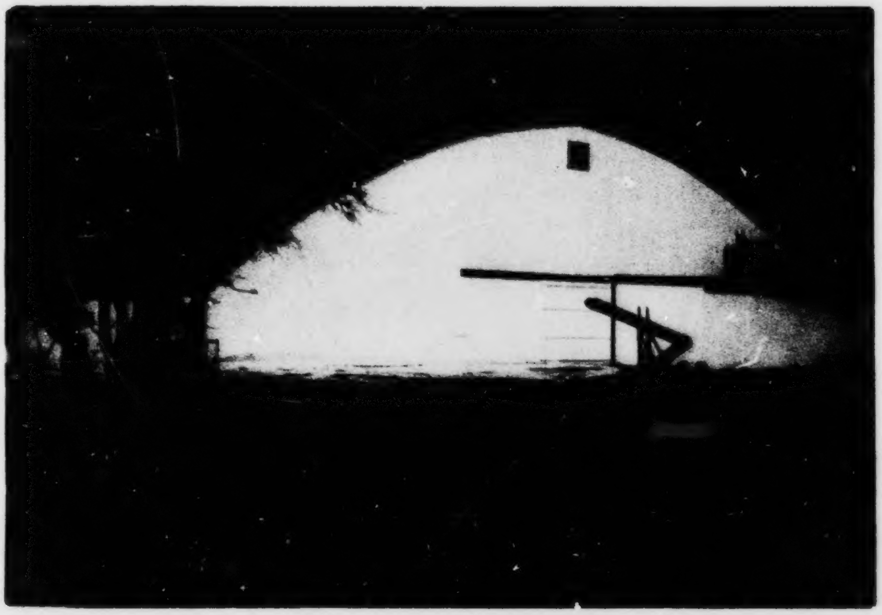


Stonewall Arena, View Looking South West

Stonewall Arena, View Looking South East



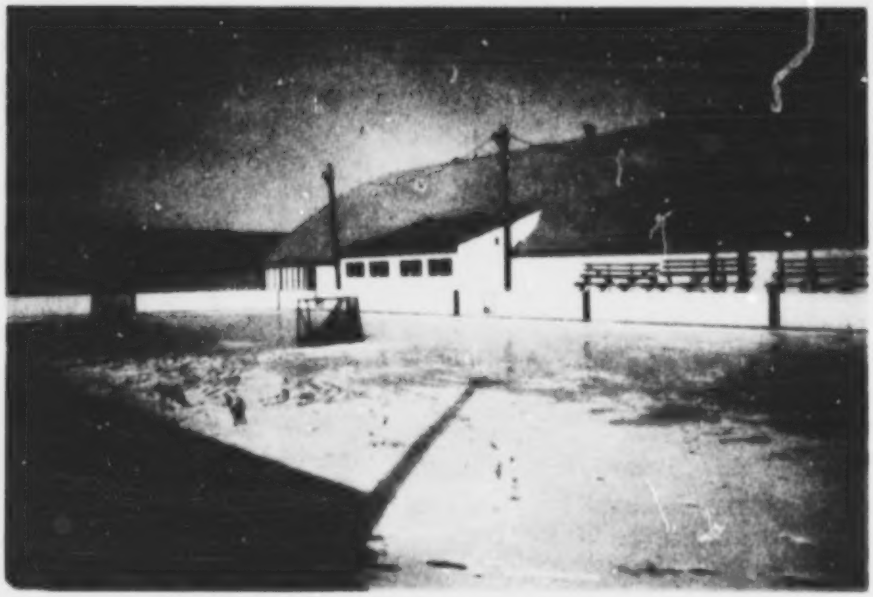
Roof Mounted Air Cooled Condenser



Stonewall Arena, View Looking West

Tractor Room

Stonewall Arena, View Looking North East



Stonewall Arena, View Looking North West

Passage From Tractor Room to Arena

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Stonewall Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
No Cost and Low Cost				
I * 5.1.1.2, 5.1.1.3 5.1.1.4 Improve weatherstripping and sealing of building heated areas. Reduce air leakage in arena and 3-level attic space.	1,400	26,744	482	3
Medium Cost				
I * 5.1.2.2 Weatherstrip exit doors and vehicle door in the Arena	600	5,560	100	6
I * 5.1.2.3 Insulate dressing room walls	1,500	-	-	?
High Cost				
I * 5.1.3.2 Replace exterior doors - 3-Level section	1,950	7,780	140	14
I 5.1.3.3 Insulate basement walls	8,000	20,833	375	21
I 5.1.3.4 Replace viewing windows with double glazed	18,000	16,333	294	27

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
Mechanical Systems				
No Cost and Low Cost				
I * 5.2.1.2 Changes to ice plant operation	0	28,837	372	Immediate
I * 5.2.1.3 Maintain minimum ice thickness	0	-	-	Immediate
I * 5.2.1.4, 5.2.1.5 Permanently wire ice plant exhaust fan and repair dampers. Install 5 kW unit heater c/w thermostat in ice plant room	400	7,751	100	4
I *5.2.1.6 Reduce ice flood water temperature	0	4,166	75	Immediate
I *5.2.1.7 Operating guidelines for canteen exhaust fan	0			Immediate
I *5.2.1.8 Operating guideline for hot water tanks	0			Immediate
I *5.2.1.9 Reduce domestic hot water temperature	0			Immediate
I *5.2.1.10 Clock thermostats (2) for 3-Level section	300	8,833	159	1.9

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
I *5.2.1.11 Clock thermostat for change room	150	2,780	50	3
I *5.2.1.12 Operating guideline for gas furnace	-			Immediate
I *5.2.1.13 Guideline for operation of equipment	0			Immediate
I *5.2.1.14 Upgrade housekeeping practice	0			Immediate
I *5.2.1.15 Guideline for monitoring maintenance and checking of mechanical equipment	0			Immediate
Medium Cost				
*5.2.2.2 Modify controls for arena ice plant	600	9,975	129	4.6
I *5.2.2.3 New exhaust fans/switches for washrooms	600			0
I Install new DHW tank for showers	1000			-

Building		Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
High Cost					
I	*5.2.3.2 Heat recovery from arena ice plant	5,000	47,641	772	7.8
	5.2.3.3 Water treatment equipment	-			-
	5.2.3.4 Arena updraft fans	3,000			-
I	Add 50 hp	12,000	-	1,807	6.6
Electrical Systems					
No Cost and Low Cost					
I	*5.3.1 Guidelines for light switching and lamp replacement	-			-
Medium Cost					
	*5.3.2.2 Replace hall G-05 lighting with fluorescent	180	686	55	3.2
	*5.3.2.3 Replace basement change room and hall lighting with fluorescent	1,350	3,360	198	6.8
	*5.3.2.4 Replace ground floor change room lighting with fluorescent	140	180	11	13.3

Building		Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
I	*5.3.2.5 Remove one outside light fixture per pole	100	4,800	194	.5
High Cost					
	Amalgamate electrical services	4,200	-	646	6.5

Energy consumption and cost monitoring of the retrofitted facility is in progress. This data will be provided in a future report.

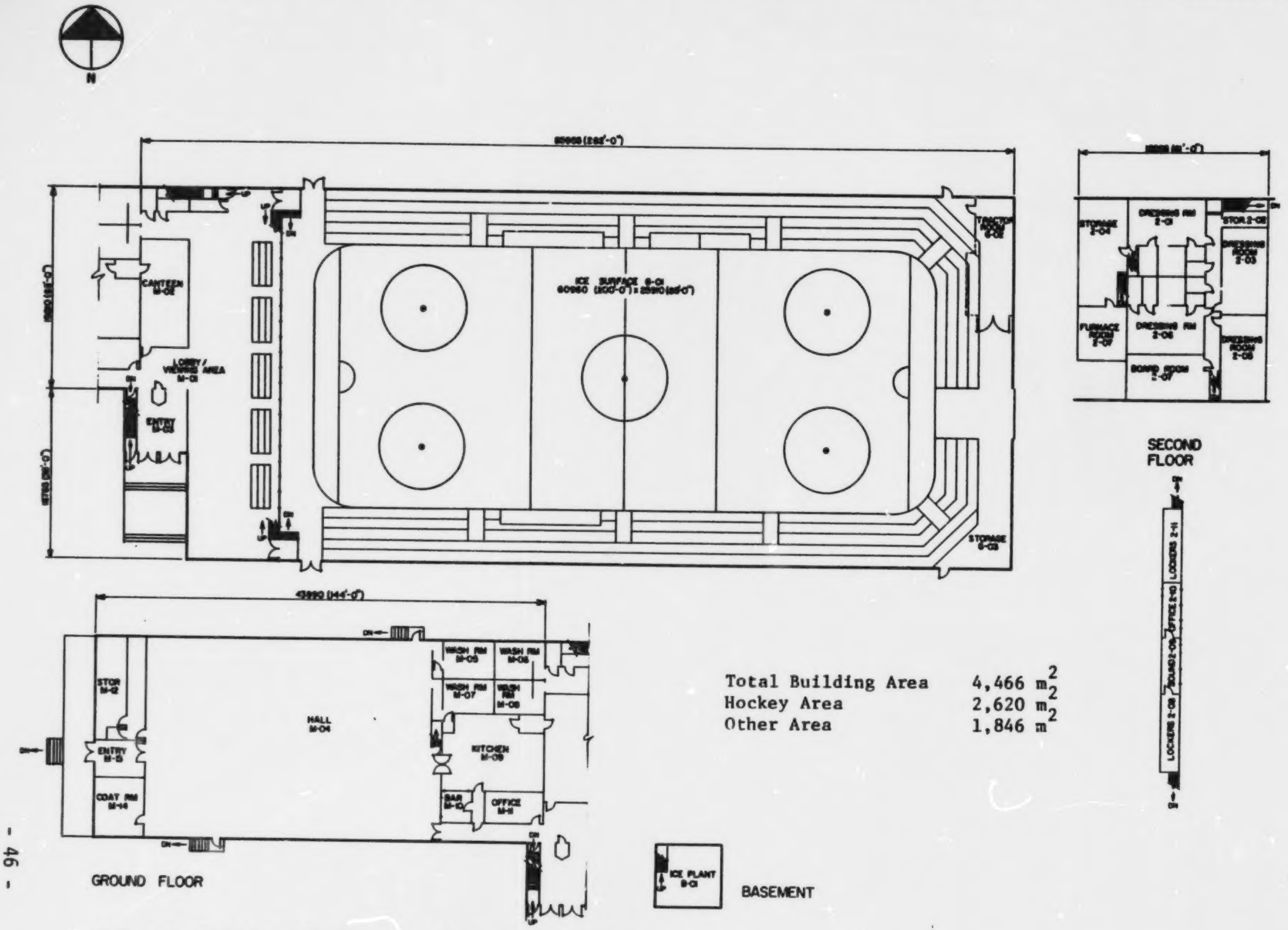
3.4 Yellowhead Centre (Neepawa)

.1 General Description

The Yellowhead Centre (Figures 4(a) to 4(g)) is a recreation facility made up of a community hall and an arena. The community hall, constructed in approximately 1930, is a wood frame structure. The walls were insulated in 1974, and the roof remained uninsulated. The arena is an insulated steel frame building constructed in 1972. The artificial ice plant was included at the time of construction. In 1974 the exterior of the entire facility was re-faced with metal siding. The building is heated with a combination of electricity and natural gas, except for the arena proper, which is unheated (i.e. plans are to remove the radiant heating from the bleacher area in the summer of 1983). Lighting in the arena is predominantly mercury vapour with some incandescent. Lighting in the remainder of the building is mainly incandescent. Sewer and water services are provided by the town. Mechanical and electrical systems in the building are generally of 1972 vintage, with the exception of a gas-fired furnace installed in the community hall in 1982.

.2 Pre-Retrofit Energy Consumption

The pre-retrofit energy consumptions and costs for The Yellowhead Centre are detailed in Appendix A. The total annual energy consumption (1982 was 984,939 kWh - 3,546 GJ) at a cost of $26,543.


N
80900 (282'-0")
ICE SURFACE 0-01
60960 (200'-0") x 25910 (85'-0")
CANTEEN
M-02
LOBBY /
VIEWING AREA
M-01
ENTRY
M-03
TRACTOR ROOM
0-02
STORAGE
0-03
UP
DN
43890 (144'-0")
STOR
M-12
ENTRY
M-13
COAT RM
M-14
HALL
M-04
WASH RM
M-05
WASH RM
M-06
WASH RM
M-07
WASH RM
M-08
KITCHEN
M-09
BAR
M-10
OFFICE
M-11
GROUND FLOOR
DRESSING RM
2-01
STORAGE
2-04
STOR 2-02
DRESSING ROOM
2-03
FURNACE ROOM
2-07
DRESSING RM
2-06
DRESSING ROOM
2-05
BOARD ROOM
2-07
SECOND
FLOOR
LOCKERS 2-11
OFFICE 2-10
SOUND 2-09
LOCKERS 2-08
ICE PLANT
B-01
BASEMENT

Total Building Area	4,466 m^2
Hockey Area	2,620 m^2
Other Area	1,846 m^2

THE YELLOWHEAD CENTER NEEPAWA MANITOBA

Fig. 4 (a)

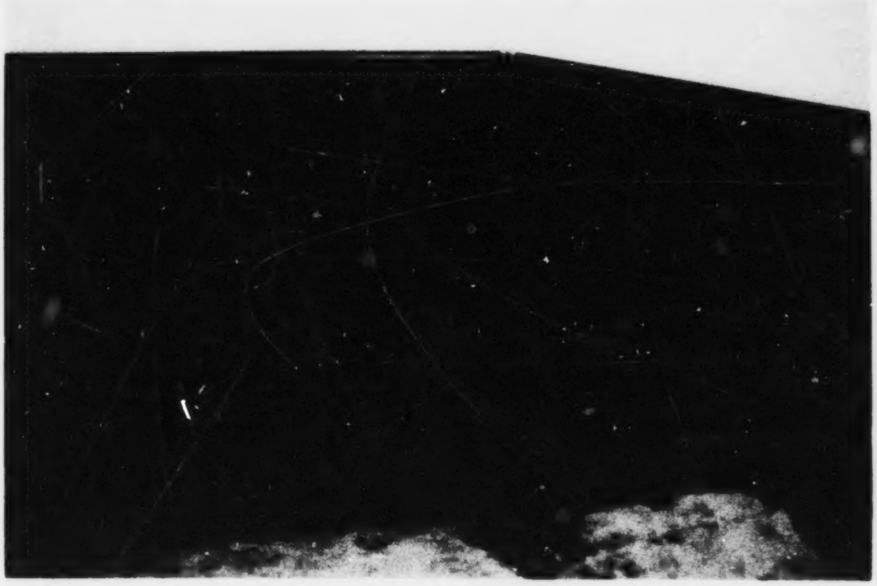
Yellowhead Centre, Main Entrance

Yellowhead Centre, View from South West

Yellowhead Centre, View from West

Yellowhead Centre, View from North West

Yellowhead Centre, View from East



Arena Vehicle Door, and Exhaust Fan Back Draft Dampers

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Yellowhead Centre (Neepawa)

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
No Cost and Low Cost				
I * 5.1.1.2 to 5.1.1.4 Improve weather-stripping and sealing of Tractor room and arena vehicle doors Seal snow chute	450	7,752	100	4.5
Medium Cost				
I * 5.1.2.2 Improve weather-stripping and sealing of building heated areas	1,500	52,248	674	2
I * 5.1.2.3 Replace weather-strip man doors in the Arena	5,000	1,752	100	-
I * 5.1.3.2 Replace exterior doors - Central Area	3,510	12,150	258	14
I * 5.1.3.3 Insulate Community Hall walls	20,000	1,234	1,539	13

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
Mechanical Systems				
No Cost and Low Cost				
I * 5.2.1.2 Changes to ice plant operation	0			Immediate
I * 5.2.1.3 Maintain minimum ice thickness	0			Immediate
I * 5.2.1.4 Replace back-draft dampers for the exhaust fan in the Compressor room	75			-
I * 5.2.1.5 Install make-up air backdraft dampers and plenum in Compressor room	200			-
I * 5.2.1.6 Operating guide-line for compressor room and tractor room unit heaters	0			Immediate
I * 5.2.1.7 Operating guide-lines for canteen exhaust fan	0			Immediate
I * 5.2.1.8 Reduce ice flood water temperatures	0	3,721	48	Immediate
I * 5.2.1.9 Reduce domestic hot water temperatures	0			Immediate

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

	Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
I	* 5.2.1.10 Operating guideline for hot water tanks	0			Immediate
I	* 5.2.1.11 Guideline for monitoring maintenance and checking of mechanical equipment	0			Immediate
I	* 5.2.1.12 Clean electric heaters and set back temperature, etc.	0			Immediate
I	* 5.2.1.13 Guideline for operation of equipment	0			Immediate
I	* 5.2.1.14 Upgrade housekeeping practices	0			Immediate
I	* 5.2.1.15 Repair backdraft dampers for Arena exhaust fans	200			?
	Medium Cost				
	* 5.2.2.2 Install motorized dampers in Community Hall	600	11,085	143	4.2
	* 5.2.2.3 Install control system for convection heaters	2,000	5,426	70	29

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
High Cost				
I * 5.2.3.2 Heat recovery from Arena Ice Plant	4,000	27,907	360	11
5.2.3.3 Water treatment equipment	-			-
5.2.3.4 Arena updraft fans	3,000			-
No Cost and Low Cost				
I * 5.3.1.2 Guidelines for maintenance and operation of Arena lights	100			?
I * 5.3.1.3 Guidelines for operation of change room lights	0			Immediate
I * 5.3.1.4 Guidelines for operation of outdoor rink lights	0			Immediate
I * 5.3.1.5 and I * 5.3.1.6 Lamp replacement program	0	7,597	98	Immediate
I * 5.3.1.7 Control water heaters	400			-

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
I * 5.3.1.8 Guidelines for operation of kitchen equipment	0			-
Medium Cost				
I * 5.3.2.2 Replace incandescent lighting with fluorescent in Lobby	2,400	3,425	186	13
I * 5.3.2.3 Replace incandescent lighting with fluorescent on Second Floor	1,200	1,056	117	10.3
I * 5.3.2.4 Install capacitor	1,200	-	667	1.8
High Cost				
* 5.3.3.2 Replace incandescent lighting with fluorescent in Hall	5,400	3,450	525	10.3

Energy consumption and cost monitoring of the retrofitted facility is in progress. This data will be provided in a future report.

3.5 Roblin and District Arena

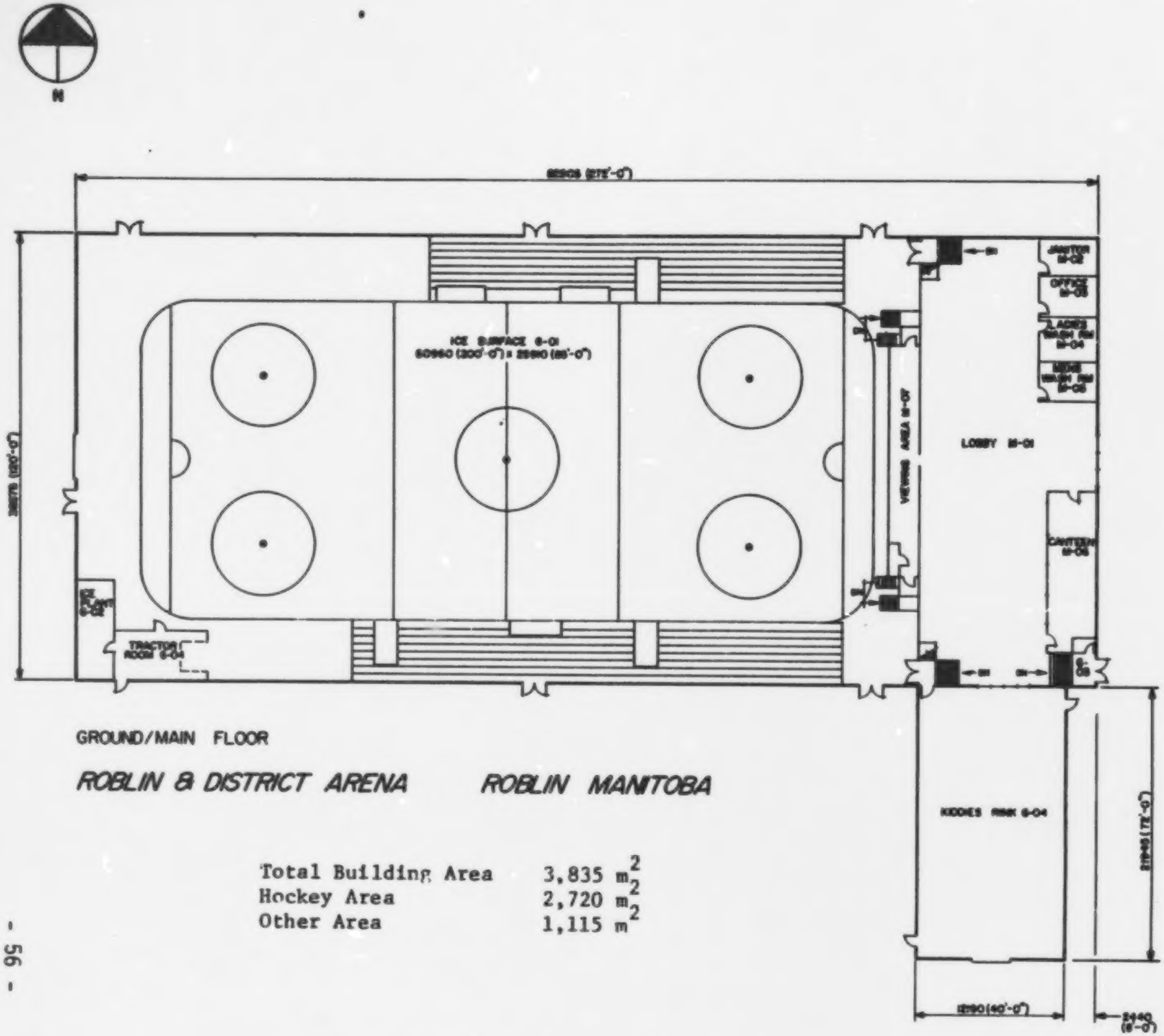
.1 General Description

The Roblin and District Arena (Figure 5 (a) to 5 (c)) was constructed in 1967 and consists of two ice surfaces - an arena and a kiddies' rink. The concrete block building is electrically heated with the exception of the rink areas which are unheated. Lighting in the complex consists of mercury vapour in the arena, incandescent in the kiddies' rink and predominantly fluorescent with some incandescent in the lobby and dressing areas.

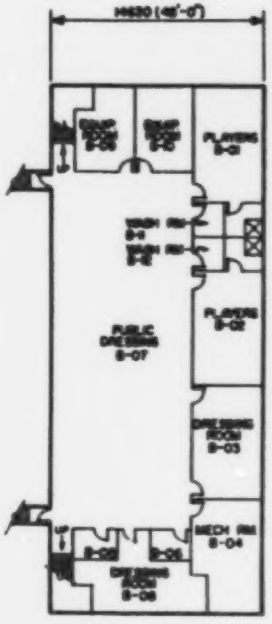
The arena has artifical ice and the kiddies' skating rink has natural ice. The water supply and sewer system are both provided by the town. The building mechanical and electrical systems are generally of 1967 vintage, with only minor revisions made since original building construction.

.2 Pre-Retrofit Energy Consumption

The pre-retrofit energy consumptions and costs for Roblin and District Arena are detailed in Appendix A. The total annual energy consumption (1982) was 409,950 kWh (1,476 GJ) at a cost of $14,680.


N
82905 (272'-0")
36575 (120'-0")
ICE SURFACE G-01
60960 (200'-0") x 25910 (85'-0")
VIEWING AREA M-07
LOBBY M-01
JANITOR M-02
OFFICE M-03
LADIES WASH RM M-04
MENS WASH RM M-05
CANTEEN M-06
KIDDIES RINK G-04
ICE PLANT G-02
TRACTOR ROOM G-04
21945 (72'-0")
12190 (40'-0")
2440 (8'-0")

GROUND/MAIN FLOOR


14630 (48'-0")
PLAYERS B-01
PLAYERS B-02
WASH RM
WASH RM
PUBLIC DRESSING B-07
DRESSING ROOM B-03
MECH RM B-04
DRESSING ROOM B-08
UP

BASEMENT

ROBLIN & DISTRICT ARENA ROBLIN MANITOBA

Total Building Area	3,835 m^2
Hockey Area	2,720 m^2
Other Area	1,115 m^2

Fig. 5 (a)

Roblin Arena, View from South West

Roblin Arena, View from West

Roblin & District Arena, View From East

Kiddies Rink, View From South

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Roblin and District Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
No Cost and Low Cost				
I * 5.1.1.2 Improve weatherstripping and sealing of building heated areas	500	25,710	332	3
I * 5.1.1.3 Repair Arena ice area air leakage areas	500			
Medium Cost				
I * 5.1.2.2 and 5.1.2.3 Weatherstrip exit and vehicle doors in the Arena	920	10,078	130	7
I * 5.1.2.4 Weatherstrip heated arena doors	540	15,504	200	2.7
I * 5.1.2.5 Install steel	390	1,350	17	22
High Cost				
I * 5.1.3.2 Insulate 2-level section	17,220	111,086	4,695	4

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Roblin and District Arena

	Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
	5.1.3.3 Replace viewing area windows with double glazed	3,840	13,876	179	21
I	Recaulk viewing area windows	500			-
	Mechanical Systems				
	No Cost and Low Cost				
I *	5.2.1.2 Changes to ice plant operation	0			Immediate
I *	5.2.1.3 Maintain minimum ice thickness	0			Immediate
I *	5.2.1.4 Operating guideline for compressor room exhaust fan	0			-
I *	5.2.1.5 Repair backdraft dampers seals for exhaust fans in compressor room	200			?
I *	5.2.1.6 Reduce ice flood water temperature	0			Immediate

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Roblin and District Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
I * 5.2.1.7 Reduce temperature in Tractor Room and compressor room	0			Immediate
I * 5.2.1.8 Operating guidelines for canteen exhaust fans	0			Immediate
I * 5.2.1.9 Operating guidelines for hot water tanks	0			Immediate
I * 5.2.1.10 Reduce domestic hot water temperature	0			Immediate
I * 5.2.1.11 Guideline for monitoring maintenance and checking of mechanical equipment	0			Immediate
I * 5.2.1.12 Clean force flow heaters and set back temperature, etc.	0			Immediate
I * 5.2.1.13 Guideline for operation of equipment	0			Immediate

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Roblin and District Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
I * 5.2.1.14 Upgrade housekeeping practices	0			Immediate
I * 5.2.1.15 Replace compressor drive belts	60			-
High Cost				
I * 5.2.3.3 Heat recovery from Ice Plant	5,000	43,066	556	9
5.2.3.4 Water treatment equipment	-			-
I 5.2.3.5 Arena updraft fans	3,000			-
* 5.2.3.6 Engineering study	5,000			-
I * 5.3.1.2 Clean and paint reflectors	100			?
I * 5.3.1.3 to 5.3.1.6 Guidelines for maintenance and switching of lights	0			Immediate

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Roblin and District Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
I * 5.3.1.7 Re-activate demand controllers if necessary	0			Immediate
I * 5.3.1.8 Refer to 5.2.1.12				
I * 5.3.1.9 Replace incandescent with fluorescent lights	420	2,590	145	2.9
I * 5.3.1.6 Disconnect heating cable	0			Immediate
Medium Cost				
* 5.3.2.2 Replace Kiddie rink lights	1,080	1,170	87	12.5
I * 5.3.2.3 Reduce number of light fixtures in lobby	600	2,935	165	3.6
I * 5.3.2.4 Install capacitor in compressor room	1,900		727	2.6

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
High Cost				
I * 5.3.3.2 Distribute lights evenly in Arena	6,450	18,343	871	7.4

Energy consumption and cost monitoring of the retrofitted facility is in progress. This data will be provided in a future report.

3.6 Carman Community Arena

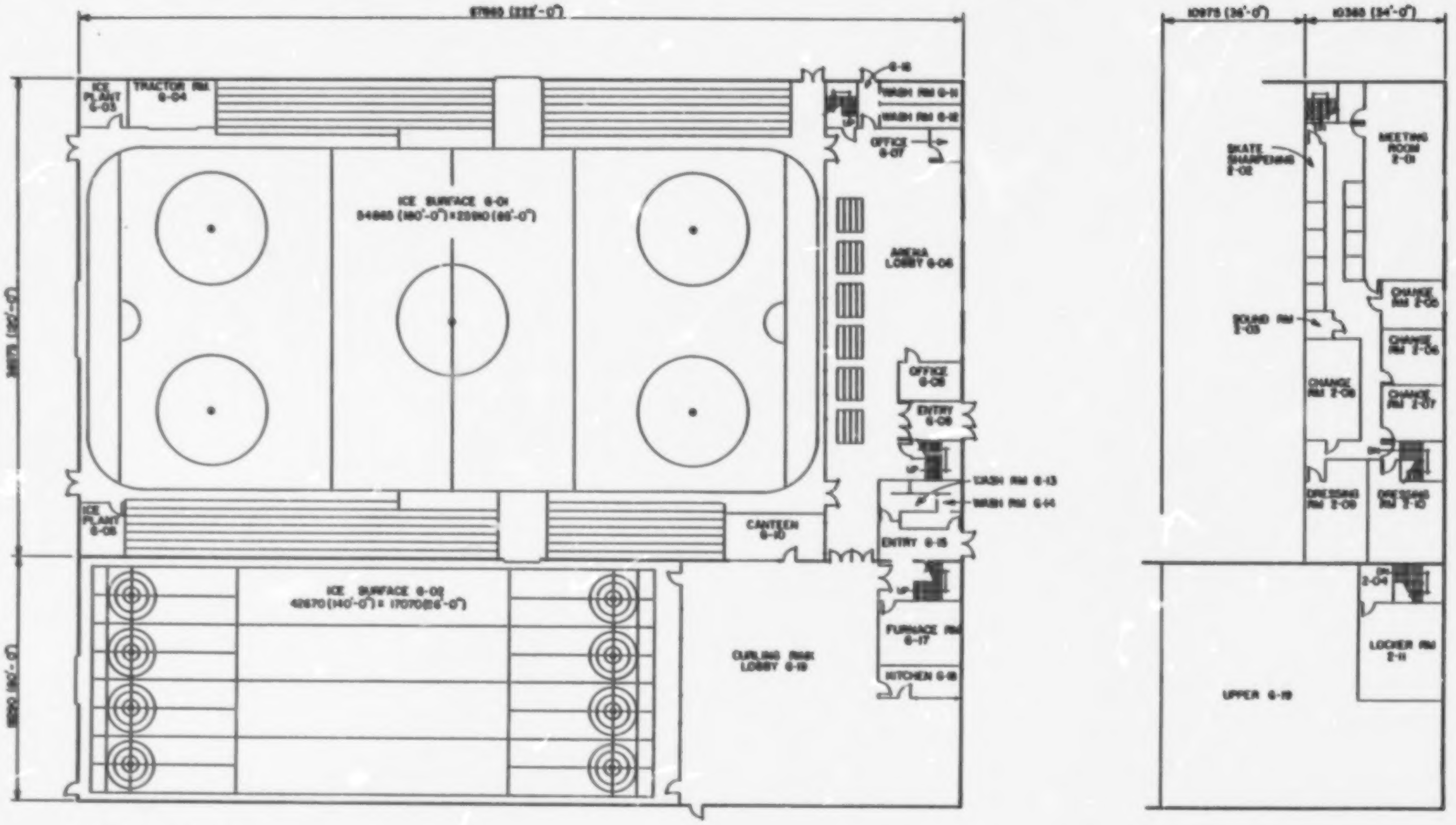
.1 General Description

The Carman Community Arena (Figures 6 (a) to 6 (c)) constructed in 1961, is a combined arena and curling rink of metal frame construction. The building is presently heated with natural gas, except for the arena which is unheated. Lighting is made up of a combination of incandescent, fluorescent and metal halide, with metal halide in the arena ice area and incandescent in the curling rink. Artificial ice in the curling rink was included at the time of construction. The water supply and sewer is provided by the Municipality. The building and its mechanical and electrical systems are generally of 1961 vintage, with the exception of major renovations in 1971, which included upgrading of the arena facility - installation of a new ice plant and uninsulated concrete floor - and upgrading and remodelling of second floor areas.

.2 Pre-Retrofit Energy Consumption

The pre-retrofit energy consumptions and costs for the Carman Community Arena are detailed in Appendix A. The total annual energy consumption (1981) was 1,377,640 kWh (4,960 GJ) at a cost of $33,390.

Total Building Area	4,158 m^2
Hockey Area	2,062 m^2
Curling A-ea	836 m^2
Other Area	1,260 m^2


ICE PLANT 6-03
TRACTOR RM 6-04
ICE SURFACE 6-01
54865 (180'-0")×25910 (85'-0")
ICE PLANT 6-05
CANTEEN 6-10
ICE SURFACE 6-02
42670 (140'-0")× 17070(56'-0")
CURLING RINK LOBBY 6-19
WASH RM 6-11
WASH RM 6-12
OFFICE 6-07
ARENA LOBBY 6-06
OFFICE 6-08
ENTRY 6-09
WASH RM 6-13
WASH RM 6-14
ENTRY 6-15
FURNACE RM 6-17
KITCHEN 6-18
UP
10975 (36'-0")
10365 (34'-0")
SKATE SHARPENING 2-02
MEETING ROOM 2-01
SOUND RM 2-03
CHANGE RM 2-05
CHANGE RM 2-06
CHANGE RM 2-08
CHANGE RM 2-07
DRESSING RM 2-09
DRESSING RM 2-10
2-04
LOCKER RM 2-11
UPPER 6-19

GROUND FLOOR

SECOND FLOOR

CARMAN COMMUNITY ARENA CARMAN MANITOBA

Fig. 6 (a)

Carman Community Arena, View From South East

Carman Community Arena, View From South

Carman Community Arena, View From North West

Carman Community Arena, View From North

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Carman Community Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
No Cost and Low Cost				
I * 5.1.1.2 Replace ceiling tiles - C.R. Lobby	-			-
Medium Cost				
I * 5.1.2.3 and 5.1.2.3 Weatherstripping and sealing improvements	1,525	66,358	1,075	1.5
I * 5.1.2.4 Repair insulation and fireproofing	?			?
* 5.1.2.5 Replace windows with in-fill panels	1,600	17,284	280	6
High Cost				
5.1.3.2 Replace 6 doors with insulated doors	2,400	8,100	131	18
* 5.1.3.3 Replace viewing area windows with double - pane windows	8,200	12,965	210	25 - 30

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Carman Community Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
Mechanical Systems				
No Cost and Low Cost Retrofit				
* 5.2.1.2 * 5.2.1.3 Operating Guidelines	-			-
I 5.2.1.4 Repair and reinstate washroom exhaust fan operation	1,000			-
* 5.2.1.5 to 5.2.1.16 Operating Guidelines	-			?
* 5.2.1.17 Weatherstripping on make-up air into arena and curling rink	200	6,172	100	2
Medium Cost				
* 5.2.2.2 Night set back thermostat and time clock for curling rink	1,000	13,827	224	4
* 5.2.2.3 Night thermostat and time clock for ice slab temperature	800	9,877	160	5

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Carman Community Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
* 5.2.2.4 Night set back (clock) thermostats for 3 existing furnaces	600	12,284	199	3
High Cost				
* 5.2.3.2 Heat recovery from ice plant	42,000	435,185	7,050	6
5.2.3.3 Water treatment equipment	-			-
5.2.3.4 Arena and curling rink updraft fans	3,600			-
I * 5.2.3.5 Dump ice shavings outside	?			Immediate
Electrical Systems				
No Cost and Low Cost				
* 5.3.1.2 Guideline for maintenance and * switching of curling rink lighting	300			?
* 5.3.1.3 Guideline for maintenance and * switching of curling rink and lobby lighting	100			?

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Carman Community Arena

	Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
I	* 5.3.1.4 Switch off change room lighting when not required	-			Immediate
	* 5.3.1.5 Change washroom lighting to fluorescent	280	993	87	3.2
I	* 5.3.1.6 Change corridor lighting to fluorescent	400	3,310	157	2.5
I	* 5.3.1.7 Change change room lighting to fluorescent	225	1,986	94	2.4
I	* 5.3.2.2 Replace additional change room lighting with fluorescent	600	5,296	251	2.4
	* 5.3.2.3 Replace curling rink lobby lighting with fluorescent	1,575	1,900	122	12.8
	* 5.3.2.4 Power factor correction	1,100		529	2

.3 Summary of Considered, Recommended(*) and Implemented (I) Retrofit Options

Carman Community Arena

Building	Estimated Capital Costs ($)	Estimated Energy Savings kWh/Yr.	Estimated Cost $/Yr.	Estimated Payback Period (Yr.)
High Cost				
I * 5.3.3.2 Convert curling rink lighting to fluorescent	4,900	11,188	591	8.2
5.3.3.3 Combine electrical services	16,000		1,207	13

Energy consumption and cost monitoring of the retrofitted facility is in progress. This data will be provided in a future report.

CONCLUSIONS & RECOMMENDATIONS

4. CONCLUSIONS AND RECOMMENDATIONS

.1 Conclusions

The study and retrofit of six rural arenas in Manitoba has shown that excellent potential for energy conservation exists. There are approximately 200 such facilities in Manitoba, which indicates a potential energy saving of some 214,000 gigajoules (GJ) annually and a potential energy cost savings of approximately $2 million. This, in turn, represents good potential for the construction industry, with capital expenditures which could exceed $12 million.

The payback period for retrofit work on the average is less than 5 years, which indicates that even without government funding arenas should consider borrowing as a means of financing energy retrofit programs.

Potential areas of major energy savings are as follows:

.1 Air Leakage
.2 Ice Plant Heat Rejection
.3 Inefficient lighting
.4 Lack of insulation
.5 Oversized Ice Plant
.6 Power Factor Correction

It is extremely important that the procedures, entitled "Five Steps to an Energy Management Program" in the 'seminar manual', are adhered to whenever embarking on a retrofit program. It is equally as important that a qualified consultant be hired to perform the necessary audit and evaluation.

Based on the investigation of all arenas, the potential areas of major energy savings are expanded as follows:

.1 Air Leakage

Annual savings of $6,100 were estimated as a result of reduction in air leakage in at least the following ways:

.1 caulking and weatherstripping doors and windows
.2 adjusting fit at entrances
.3 sealing of fresh air intake dampers and exhaust fan backdraft dampers
.4 sealing of building openings.

A capital expenditure, estimated to be $18,900 for the six arenas, makes this an excellent retrofit project with a simple payback period of 3.1 years.

.2 Rejection of Heat from Ice Plant Compressors to Outdoors

Recovery of heat normally rejected to the outdoors was utilized in both space heating and domestic and flood water heating applications.

Capital expenditure in the six arenas was estimated to be $157,500. Annual savings of approximately $34,400 indicates that this retrofit method could be examined in any arena. Payback periods will be approximately 4.6 years.

.3 Inefficient Lighting Systems

Lighting systems in general were upgraded to be consistent with IES (Illuminating Engineering Society) guidelines. It is generally found to be economical to convert from incandescent lighting to a more efficient light source, such as fluorescent and/or metal halide.

Lighting revisions in this project accounted for an estimated capital expenditure of $41,000, and annual energy cost savings of $6,700 - a payback period of 6.1 years.

.4 Lack of Insulation in Walls and Ceilings

The economic feasibility of adding insulation is very dependent upon the existing insulation level and the type of heating system in the building. Insulation levels in the facilities surveyed range from extremely poor to good. A competent consultant should be hired to analyse the feasibility of adding insulation.

Under this program, insulation was added at the Roblin Arena for a cost of $25,000, which included exterior metal siding. Annual savings estimated at $4,700 will yield a payback period of just over 5 years. It should be noted that the walls were originally not insulated.

.5 Oversized Ice Plant

Where arenas are equipped with a single compressor, it can cause excessive electrical demand charges and high electrical costs. In the Stonewall Arena, a smaller (50 HP) compressor was installed to operate during the winter months. During this time, the outdoor conditions are such that the ice plant operating hours are greatly reduced.

Energy cost savings of $1,800 were estimated in the above mentioned case. With a capital expenditure estimated to be $12,000, this resulted in a payback period of approximately 5.6 years.

.6 Power Factor Correction

Power factor correction represents an excellent means of reducing energy costs in arenas. Capacitors were installed on each compressor under this retrofit program. The total cost for all arenas was estimated to be $9.700. Annual cost savings were estimated at $5,900, giving a payback period of 1.6 years.

4.2 Recommendations

.1 General

A substantial portion of energy costs in arenas can result from improper operation and maintenance of the building and its systems. The arena manual, which was prepared as part of the total retrofit program, identifies and describes various means by which energy use can be reduced via operational changes and proper maintenance. The arena manual should be obtained and read in conjunction with this report. As a general guideline, it is suggested that stickers and posters should be utilized to remind people to switch off lights and equipment, close doors, etc. whenever possible. Stickers are available from government departments (EMR).

The following are recommendations that should be considered in any arena:

.1 Building:

.1 Seal building openings:

Seal building openings, weatherstrip and caulk windows and doors. Adjust fit of entrances, backdraft dampers for exhaust fans, etc. A program of spot checking and upgrading should be carried out continuously, with a special effort prior to each heating season.

Seal, as well as possible, all cracks in the building shell. Weatherstrip at entrances and tractor doors even in an unheated area. This will reduce the infiltration of warm moist air in the intermediate seasons (spring and fall), thus reducing moisture and fog in the arena. Weatherstrip tractor room doors, main entrance doors, compressor room doors, all doors from central areas to ice areas.

.2 Replace Doors:

When consideration is being given to replacing doors, insulated doors should be used. If doors are in poor condition and cannot be weatherstripped properly, substantial savings may result.

.3 Blank off Windows:

Windows should, at the discretion of arena people, be blanked off with insulated, aesthetically pleasing panels.

.4 Insulate:

Insulating of walls and ceilings generally is not economical unless the existing level is quite low. A qualified consultant should be hired to assess the feasibility and method of adding insulation.

One very important area to consider is the wall which separates lobby areas from ice surface areas, as the benefits of insulating are twofold:

.1 to reduce the heat loss from the lobby,

.2 to reduce the danger of soft ice at the end of the rink closest to the lobby wall.

.2 Mechanical Systems:

.1 Night Setback:

Night setback of building temperatures provides an excellent means of reducing energy costs. The appropriate thermostats should be purchased so that night set back is accomplished automatically.

.2 Dump Shavings Outdoors:

Wherever possible, the shavings from the arena ice surface should be dumped outdoors. The substantial cost of melting these shavings is saved.

.3 Fan Operation:

Operation of ventilation fans in arenas and curling rinks should be limited to that required to eliminate carbon monoxide build-up and fog. Operate fans only long enough to remove the fog.

In both heated and unheated arenas, whenever the outdoor temperature is higher than the ice area temperature, the fan should generally not be used for fog removal; i.e. the humidity in the outside air will normally be greater, thus causing even more fog.

.4 Ice Plant Heat Recovery:

Consider utilizing heat being rejected to outdoors for building heating and domestic and flood water heating. A competent engineer should be hired to make an assessment of each situation and recommend the best method of heat recovery.

In unheated, uninsulated arenas it is not practical to consider heat recovery from the ice plant in a space heating application; however, heat can be recovered for use in ice flood water pre-heating, using commercially available equipment.

In heated ice areas it is practical to consider utilization of rejected heat in a space heating application.

.5 Installation of Ceiling Fans:

If condensation and dripping from the underside of the roof structure has been a problem consider the installation of 'Updraft' ceiling fans to reduce or eliminate this problem.

NOTE: This is not an energy conserving retrofit.

.3 Electrical Systems:

.1 Power Factor Correction:

Power factor correction for compressor motors is an excellent cost saving retrofit item. This was recommended in all arenas surveyed.

.2 Install Smaller Compressors:

Installation of a smaller compressor should be considered in ice plants that have only a single large compressor. Electrical demand charges will thus reduce energy costs.

.3 Interlock Equipment:

Potential exists for reduction in electricity costs when a building is heated electrically. This is accomplished by interlocking the refrigeration compressors with other electrical loads (electric heat and electric domestic and ice flood water heaters).

.4 Lighting Modifications:

Lighting modifications range from switching lights off when not required to replacing an entire lighting system. In the Lorette Sports Centre, for example, the majority of the lighting was replaced. Fluorescent lighting replaced the incandescent in the curling ice area and most central lobby and dressing room areas. Metal halide fixtures replaced the incandescent lighting in the arena ice area.

APPENDIX A

APPENDIX A

DETAILED ENERGY CONSUMPTION AND COST

(Excerpts from Individual
Energy Analysis Studies)

SECTION 4 - ENERGY CONSUMPTION AND COST

4.1 General

Energy use in the facility for the 1982 year is not a true picture of past or future usage because of modifications undertaken midway through the 1982 year - in particular, addition of the arena ice plant. However, careful analysis of the data available will still result in an accurate representation of future energy costs.

4.2 Electrical Consumption, Demand and Cost

.1 General

Electrical consumption, demand and cost for the year ended January 14, 1983, is presented at the end of this section. The tabulated values are also presented graphically.

The figures for the year shown are substantially higher than for previous years, mainly due to the installation of the artificial ice plant in the arena.

.2 Electrical Consumption and Cost

From the information available on energy use in the facility, we have established the following Table. The Table is based on the proposed 1983 building operation as outlined in Section 1.2 - Building Occupancy and Use, and is intended to represent energy usage prior to implementation of retrofit projects.

	Annual Consumption (kWh)	% of Total	*Annual Cost ($)	% of Total
Ice Plant - Arena	62,100	11	3,674	18
- Curling Rink	86,000	15	2,837	13
Heating - 3 Level Section	178,000	33	6,211	35
- Curling Rink	86,000	16	2,264	11
Lighting - Arena	90,000	16	2,890	14
- Curling Rink	9,600	2	526	3
- Other	18,000	3	521	3
Other Miscellaneous Loads	34,000	4	1,705	3
Totals	563,700	100	20,628	100

* The annual cost is based on 1982 electrical data and includes the cost for both consumption and demand.

.3 Electrical Demand

From the available information, a breakdown of the building electrical demands has been established, as indicated below. We have reduced the peak of 282 kVA established in January, 1983, to 232 kVA with the assumption that the two arena compressors will not operate simultaneously in peak demand periods in future years.

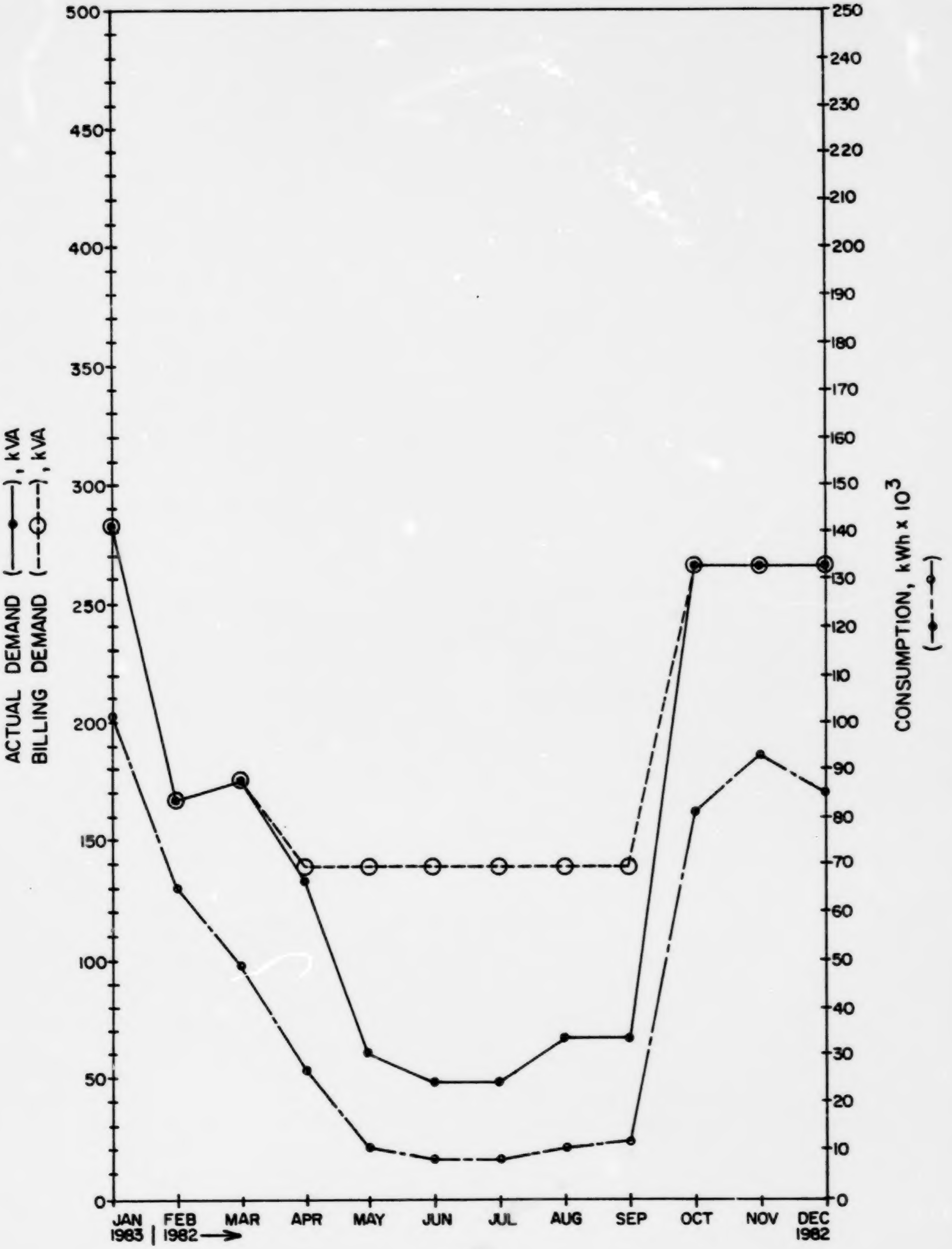
		Monthly kVA
Ice Plant	- Arena	50
	- Curling Rink	30
Heating	- 3-Level Section	70
	- Curling Rink	20
Lighting	- Arena	30
	- Curling Rink	7
	- Other	5
Other Miscellaneous Loads		20
		232 kVA

From the breakdown shown, it is apparent that the major contributors to high electrical demand are the ice plant and electric heat. A reduction in this peak can be expected as a result of recommendations for demand control given in Section 5 of this report.

TABLE 1

ELECTRICAL CONSUMPTION, DEMAND AND COST FOR YEAR ENDING JANUARY, 1983

	Electrical Consumption (kWh)	Electrical Demand (kVA)		Electrical Cost ($)	Electrical Consumption (GJ)
		Actual	Billed		
February	64,800	168	168	1,531	233.3
March	48,600	174	174	1,379	175.0
April	26,400	132	139	964	95.0
May	10,200	60	139	755	36.7
June	7,800	48	139	684	28.1
July	7,800	48	139	684	28.1
August	9,600	66	139	737	34.6
September	11,400	66	139	790	41.0
October	81,600	264	264	2,176	293.8
November	92,400	264	264	2,297	332.6
December	84,600	264	264	2,210	304.6
January, 1983	100,800	282	282	2,477	362.9
Total for Year	546,000	1,836	2,250	16,684	1,965.7



ELECTRICAL DEMAND AND CONSUMPTION
LORETTE SPORTS CENTER

SECTION 4 - ENERGY CONSUMPTION & COST

4.1 General

Energy use in the facility for the 1981 year is not a true picture of past or future usage.

There have been major changes made in the building in the 1982 year. These changes have resulted in improved energy and cost performance of the facility, and include the following:

- replacement of oil heat with propane
- replacement of electric hot water heaters with propane hot water heaters and storage tank
- addition of a new insulated ceiling over the arena lobby, capable of being utilized for a future second floor
- other general upgrading.

The data which we have relating to energy consumption and demand is based on the building as it was prior to the forementioned changes. This information is presented for reference at the end of this section.

The changes made should result in reduced heating fuel consumption and reduction in electrical demand.

4.2 Electrical Consumption, Demand and Cost

.1 General

Electrical consumption, demand and cost for the year ended November 15, 1981, is presented at the end of this section. The tabulated values are also presented graphically.

.2 Electrical Consumption

Electrical consumption for the building is a result of electric heating, lighting, ice plant operation, and other miscellaneous loads. The effect of energy conservation measures outlined in this report will be a reduction in overall consumption with increased comfort conditions in the building.

.3 Electrical Demand

One would expect a reduction in electrical demand in the 1981 winter by an amount approximately equal to the connected load of the electric water heaters removed in 1982, plus the arena compressor connected load (because of the recent interlocking of the compressor with arena radiant heating). A comparison of the electrical demand for the month ending January 15, 1981, and the same period in 1982 indicates a reduction of some 76 kVA (from 422 in 1981 to 346 in 1982).

4.3 Electrical Demand and Compressor Operating Times

.1 General

As part of our survey, we requested Mr. C. Lyons, Director of Maintenance, to

a) log the demand meter readings on an hourly basis for one full week of operation

b) log the compressor run times for both the arena and the curling rink compressors.

The data is useful in determining the heat recovery potential in this plant, as well as the potential for electrical demand control.

.2 Electrical Demand

Daily demand profiles, as developed from demand meter readings, are indicated on Graph No. 1 at the end of this Section. As well, profiles are included for average daily demands, average daily demands on week-ends, and average daily demands on week days.

From the information plotted it is apparent that peak demands, at least for the period in question, were established during the morning on week-ends. As well, the week-end daily demand in general appears to be higher than weekdays.

We would expect that the peak demand is established when the building is occupied, and it is necessary for both the arena and curling rink ice plants to operate simultaneously. A review of the curling rink compressor operation indicates that it operates virtually continuously throughout the day - on weekdays as well as week-ends.

.3 Ice Plant

The ice plant operating hours for the period commencing at 8:30 A.M., Tuesday, March 22 through to 11:30 P.M., Monday, March 28 are listed below.

	Ice Plant Operating Hours	
	Arena	Curling Rink
Tuesday	4	8.9
Wednesday	7.2	12
Thursday	5.8	20
Friday	7.8	15.9
Saturday	9.0	12.8
Sunday	10.5	15.8
Monday	6.2	12.1
TOTAL	50.5	97.5

From the information received, we have the following comments:

a) The curling rink compressor operated at least 50% of each day, and over the 7 day period (159 hours) it operated a total of 97½ hours, or 61% of the time.

b) The arena compressor operated at least 24% each day, and over the 7 day period (159 hours) it operated a total of 50½ hours, or 32% of the time.

Further reduction in electrical demand will result from general increase in efficiency of the building and its systems.

4.4 Fuel Oil Consumption

Fuel oil consumption (purchase) for the year ending December, 1981, are presented in Table 2 at the end of this section. With the conversion to propane in 1982, a reduction in energy usage should be evident as a result of increased combustion efficiency of the new equipment.

4.5 When future comparisons are made of fuel used, it is important to consider the fact that water for ice flooding, snow melting, and domestic use was (until recently) provided with electric heaters. This water is now heated using propane fuel.

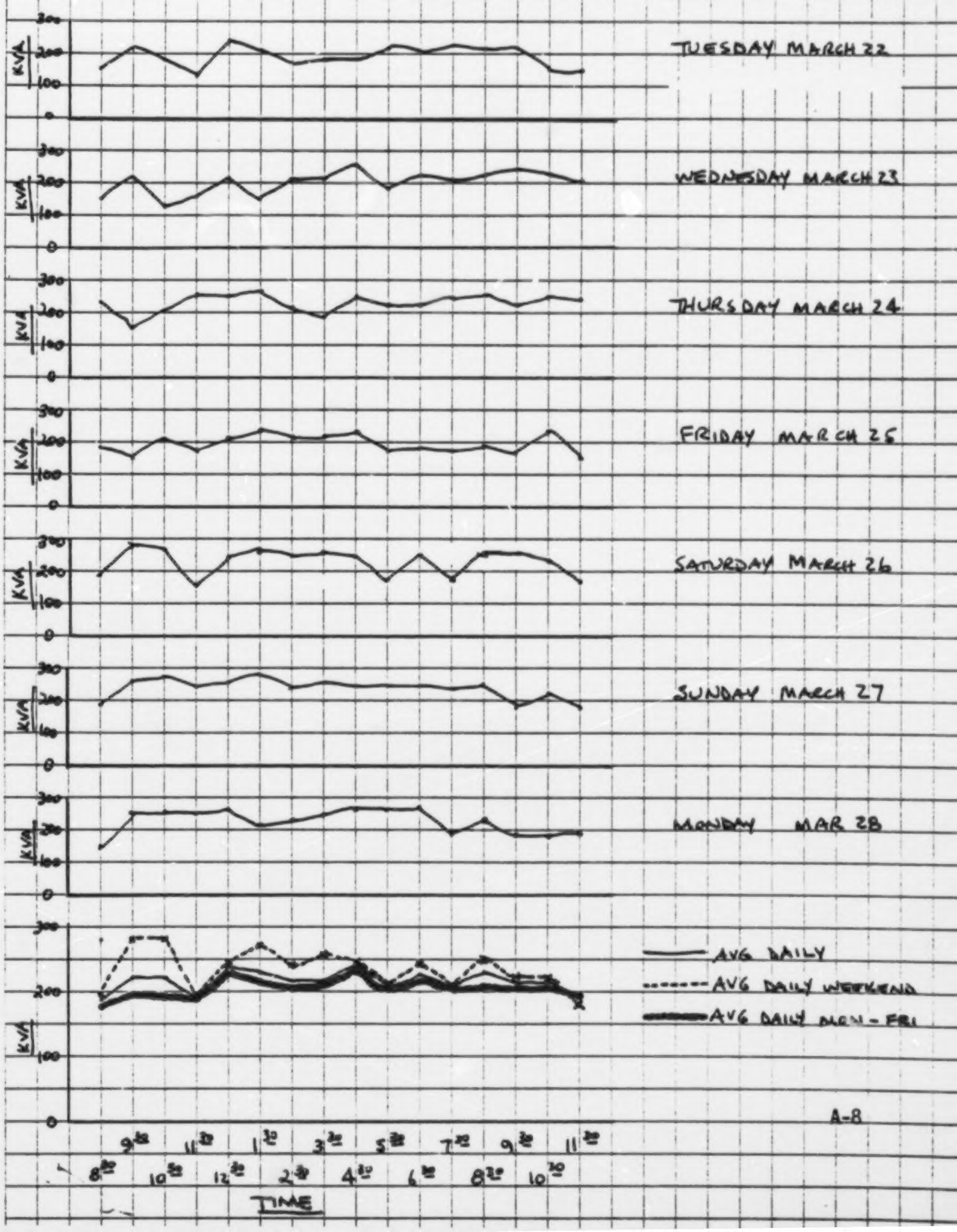
GRAPH NO. 1

**Scouten
Mitchell
Sigurdson**
Consulting Engineers

Project ROY H JOHNSTON ARENA

Design DAILY DEMAND PROFILES

Designed by	Date	Project No.	Page N
JF	APR 4/83		



THE ROY H. JOHNSTON ARENA

TABLE 1

ELECTRICAL CONSUMPTION, DEMAND AND COST FOR THE YEAR ENDING NOVEMBER, 1981

	Electrical Consumption (kWh)	Electrical Demand (kVA)		Electrical Cost ($)	Electrical Consumption GJ
		Actual	Billed		
December, 1980	101,280	363	363	3,277	364.6
January, 1981	125,280	363	363	3,559	451.0
February	130,080	353	353	3,566	468.3
March	94,080	353	353	3,143	338.7
April	* 90,000	* 363	363	3,265	324.0
May	16,320	161	290	1,864	58.8
June	10,080	48	290	1,759	36.3
July	7,200	3	290	1,669	25.9
August	7,200	48	290	1,669	25.9
September	* 45,000	* 154	290	2,406	162.0
October	136,320	353	353	3,639	490.7
November	146,400	353	353	3,758	527.1
Total for Year	909,240	2,915	3,951	33,574	3,272.3

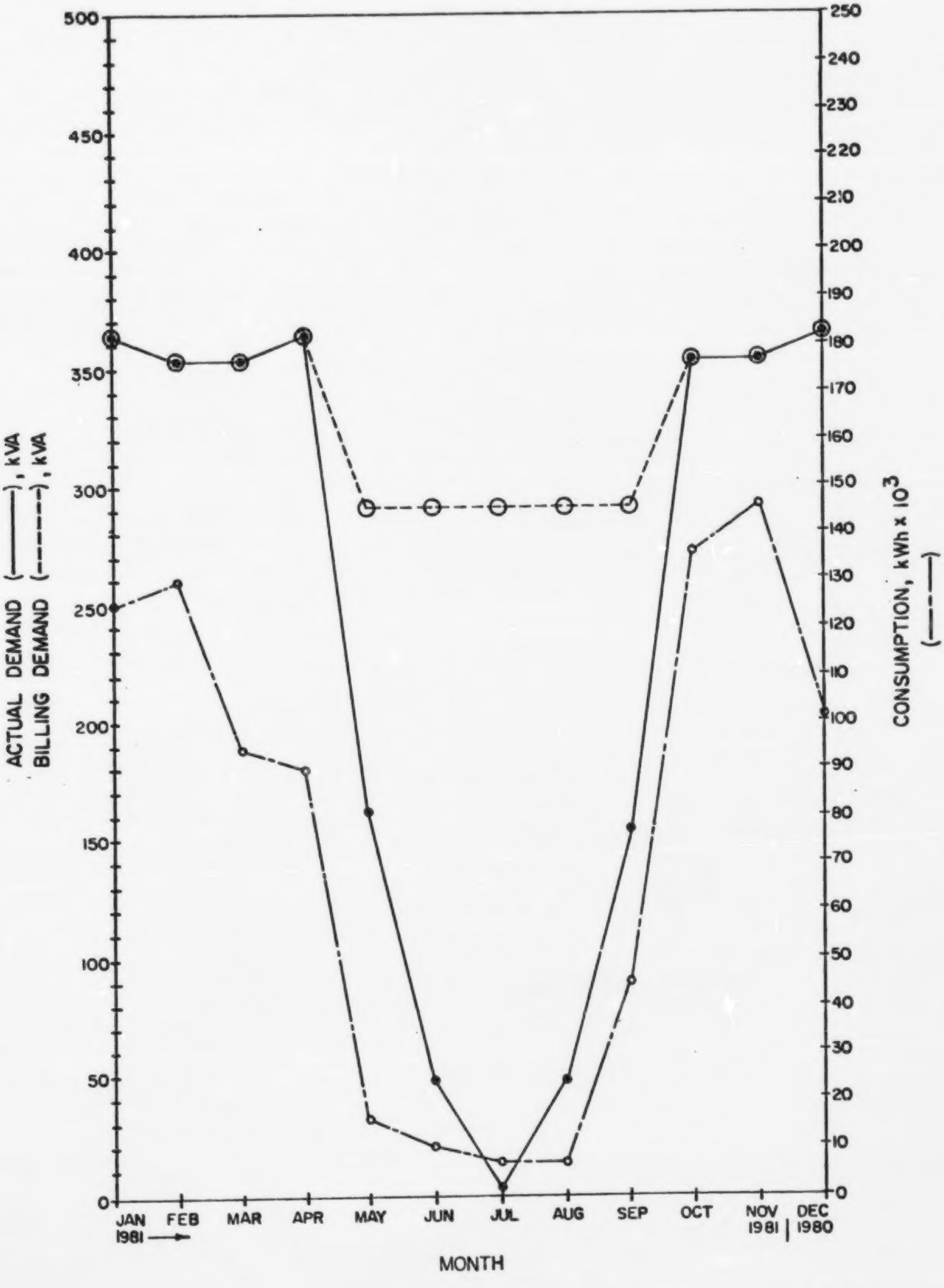
* Information estimated.

THE ROY H. JOHNSTON ARENA

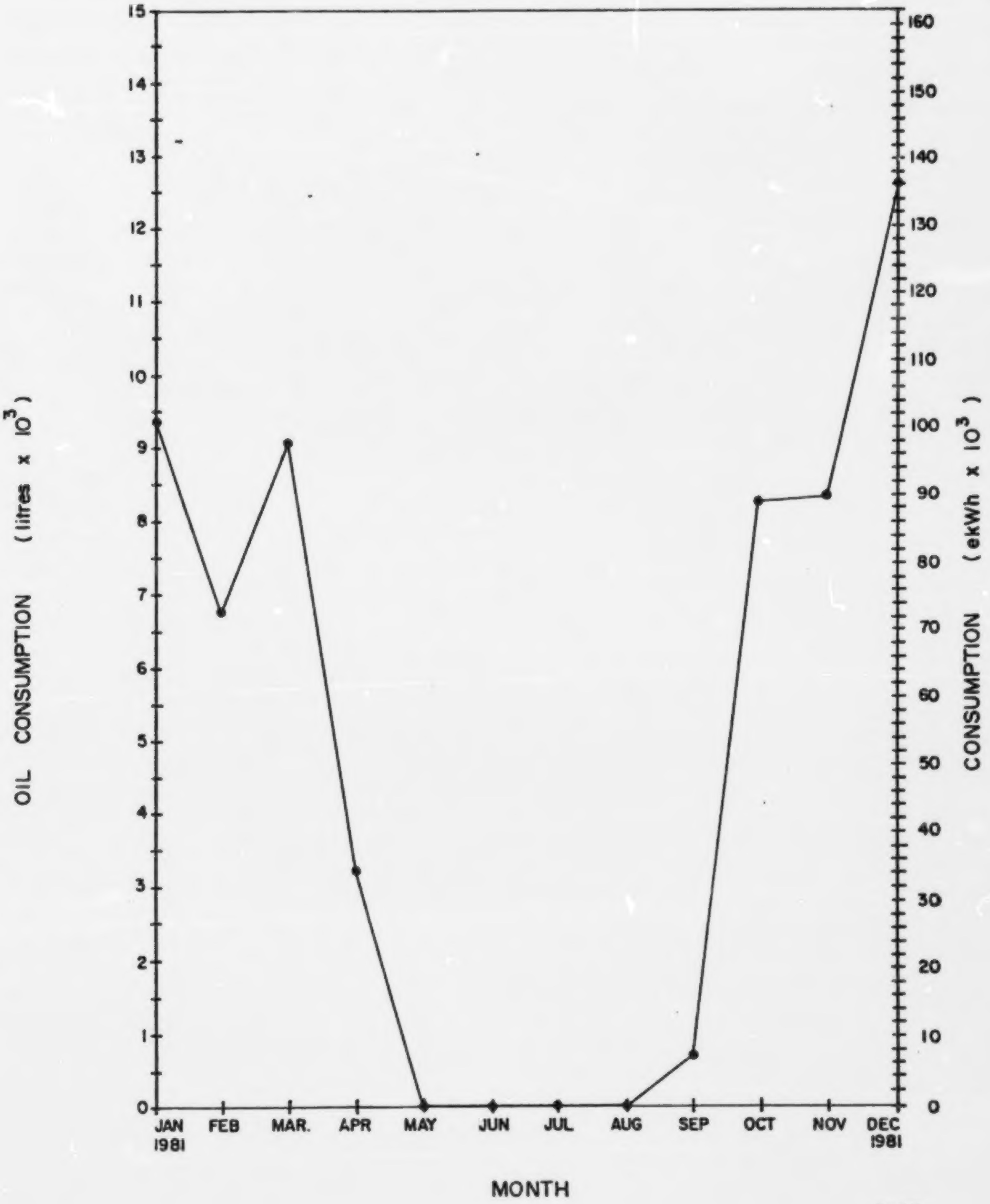
TABLE 2

FUEL OIL PURCHASES FOR THE YEAR ENDING DECEMBER, 1981

	Fuel Oil Purchases (litres)	Fuel Oil Cost ($)	Fuel Oil Purchases (GJ)
January, 1981	9,356	2,531	361
February	6,778	1,834	262
March	9,087	2,459	351
April	3,205	867	124
May	-	-	-
June	-	-	-
July	-	-	-
August	-	-	-
September	746	202	29
October	8,283	2,241	320
November	8,356	2,261	323
December	12,592	3,407	486
	58,403	$15,802	2,256



ELECTRICAL DEMAND AND CONSUMPTION
ROY H. JOHNSTON ARENA



FUEL CONSUMPTION
ROY H. JOHNSTON ARENA

SECTION 4 - ENERGY CONSUMPTION AND COST

4.1 General

The Stonewall arena has three electrical services, one general service for the new tractor room and two demand services, one for the ice plant and the other for the rest of the building (lights, outlets, electric heat). In addition, a natural gas service feeds three different areas of the building, the furnace room, the tractor room, and the south change rooms.

4.2 Electrical Consumption and Cost

.1 General

Electrical consumption, demand and cost for the year ending December 18, 1982 is presented in Table 1 at the end of this Section. The tabulated values are also presented graphically.

.2 Electrical Consumption and Cost

From the information available on energy use in the facility, we have established the following Table. The Table is based on the 1982 building operation as outlined in Section 1.2 - Building Occupancy and Use, and is intended to represent energy usage prior to implementation of retrofit projects.

		Annual Consumption (kWh)	% of Total	*Annual Cost ($)	% of Total
Ice Plant	- Arena	156,400	53	6,237.86	56
Heating	- 3 Level	23,248	7	706.85	6
	- Arena	11,985	4	364.41	3
Lighting	- 3 Level	28,299	8	860.41	8
	- Arena	54,781	16	1,665.58	16
	- Outdoor	10,653	3	323.90	3
Other Miscellaneous Loads Loads		30,794	9	936.26	8
Totals		316,160	100	11,095.27	100

.3 Electrical Demand

From the available information, a breakdown of the building electrical demands has been established, as indicated below.

	Demand (KVA)
Ice Plant and Associated Equipment	128
Heating - 3-Level Section	8
- Arena (Players Bench)	12
Lighting - Arena	14.4
- Outdoor	16
- 3-Level Section	7.5
Other Miscellaneous Loads	10

From the breakdown shown, it is apparent that the major contributors to high electrical demand are the ice plant and lighting. Some reduction in this peak can be expected as a result of recommendations given in Section 5 of this report.

4.3 Natural Gas Consumption and Cost

.1 General

Natural gas consumption and cost for the year ending December, 1982, is presented in Table 2 at the end of this Section. The tabulated values are also presented graphically.

.2 Natural Gas Consumption and Cost

From the information available on energy use in the facility, we have established the following Table. The Table is based on the present building operation as outlined in Section 1.2 - Building Occupancy and Use, and is intended to represent energy usage prior to implementation of retrofit projects.

	Annual Consumption (mcf)	% of Total	*Annual Cost ($)	% of Total
Domestic Hot Water	45	5	206.99	5
Flood Water Heating	261	31	1,200.53	31
Space Heating	537	64	2,470.06	64
Totals	843	100	3,877.58	100

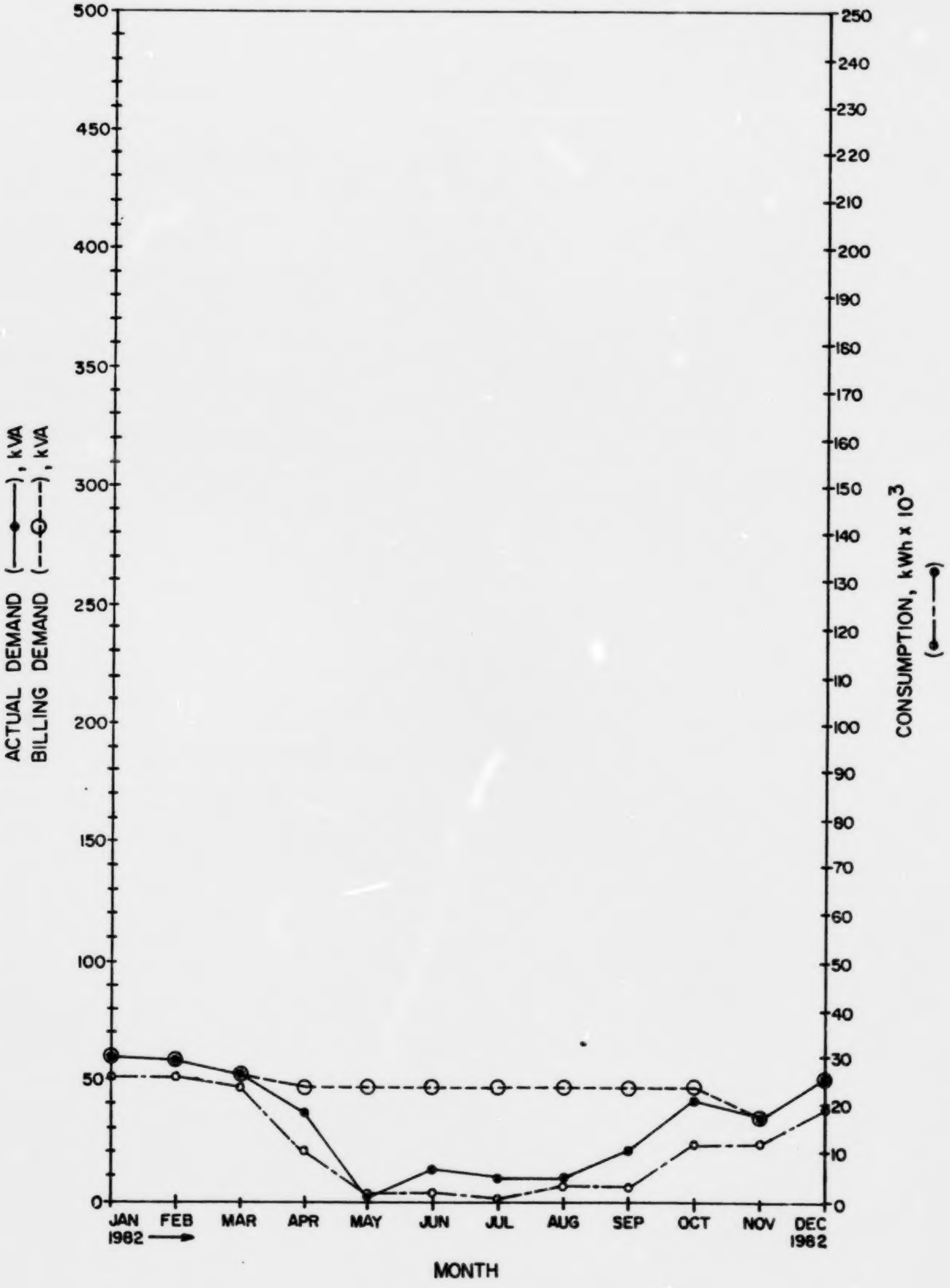
* The annual cost is based on 1982 natural gas rates.

TABLE 1

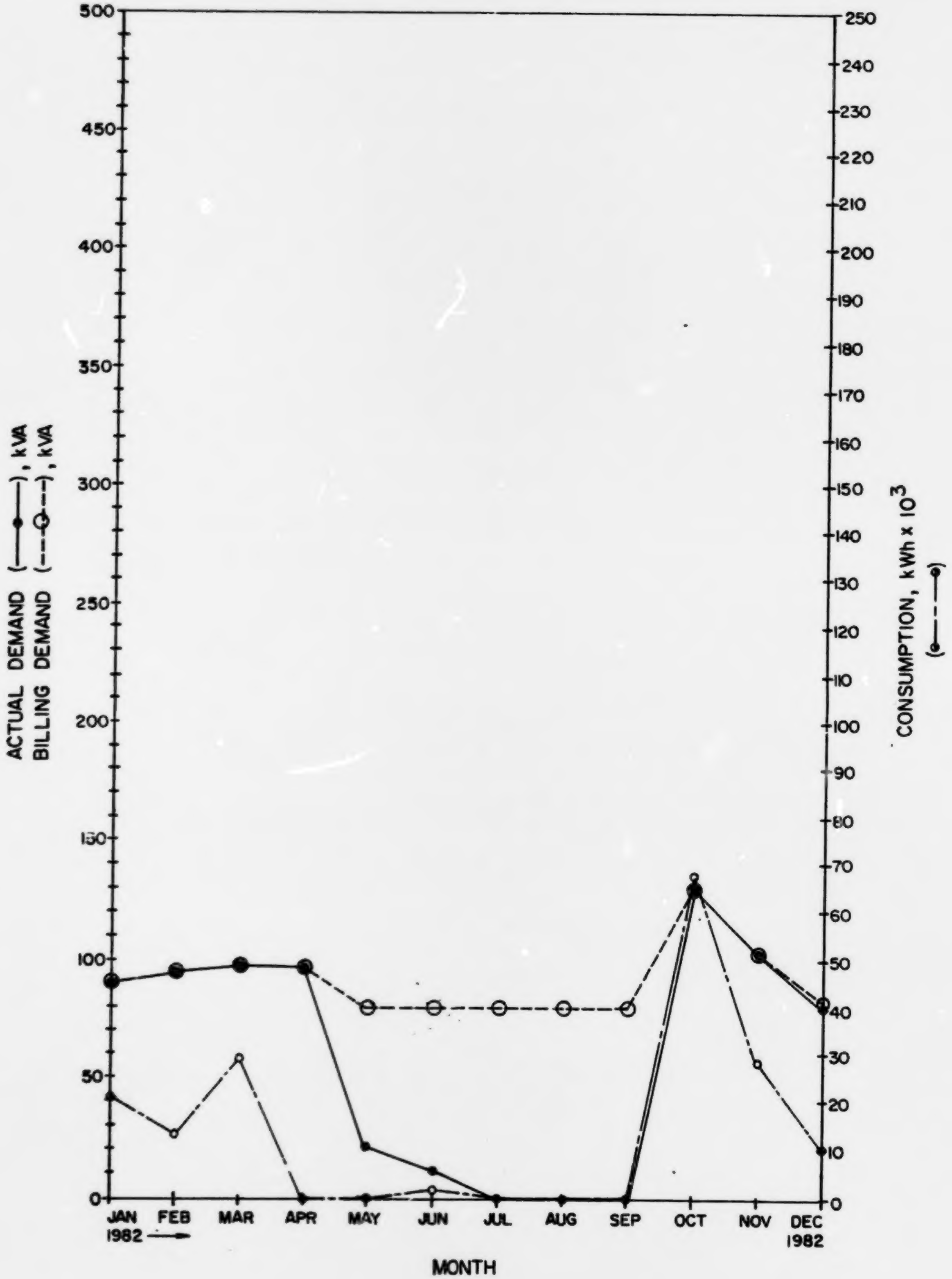
ELECTRICAL CONSUMPTION, DEMAND AND COST FOR YEAR ENDING DECEMBER, 1982

	Electrical Consumption (kWh)	* Electrical Demand (KVA) Actual	Electrical Cost ($)	Electrical Consumption (GJ)
January	32,240	141	1,104.10	116.1
February	40,250	152	1,401.36	144.9
March	51,860	147	1,469.65	186.7
April	25,140	132	1,046.32	90.5
May	3,640	23	332.20	13.1
June	5,320	22	388.21	19.2
July	1,680	9	252.91	6.1
August	3,530	9	320.12	12.7
September	3,120	20	297.81	11.2
October	79,880	169	1,876.81	287.6
November	40,410	136	1,508.44	145.5
December	29,090	129	1,097.34	104.7
Total for Year	316,160		$11,095.27	1,138.3

* Total for 2 demand meters.



ELECTRICAL DEMAND AND CONSUMPTION
STONEWALL ARENA - HEATING, LIGHTING

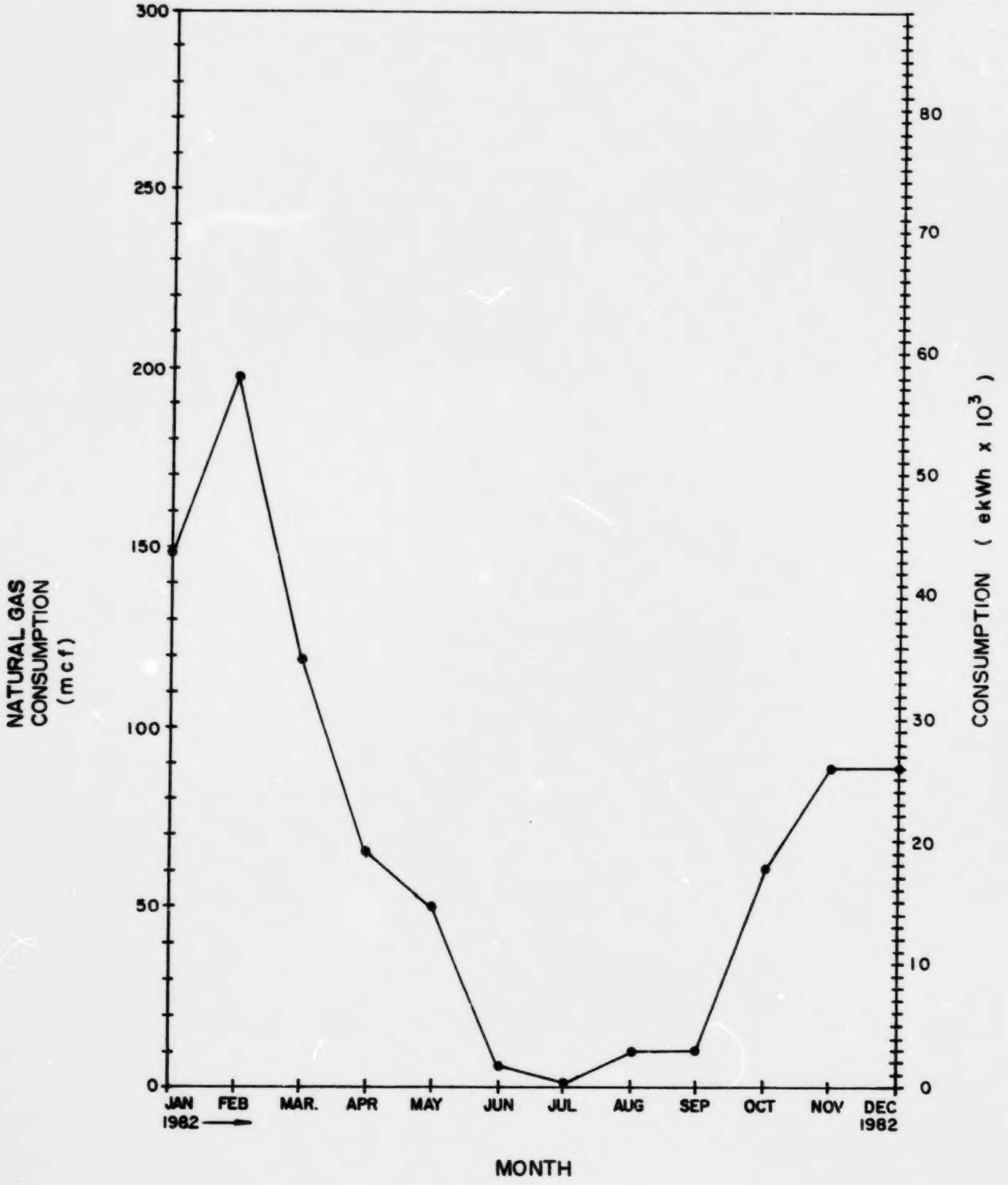


ELECTRICAL DEMAND AND CONSUMPTION
STONEWALL ARENA - ICE PLANT

TABLE 2

NATURAL GAS CONSUMPTION AND COST FOR THE YEAR ENDING DECEMBER, 1982

	Gas Consumption (mcf)	Gas Cost ($)	Gas Consumption (GJ)
January	149	597.02	156
February	197	787.69	206
March	119	544.71	125
April	65	299.83	68
May	50	232.34	52
June	5	25.76	5
July	1	15.72	1
August	10	57.27	10
September	10	60.26	10
October	61	326.55	64
November	88	467.00	92
December	88	463.43	92
Total for Year	843	3,877.58	881



FUEL CONSUMPTION
STONEWALL ARENA

SECTION 4 - ENERGY CONSUMPTION AND COST

4.1 General

The Yellowhead Centre is fed by one electric demand service for distribution throughout the entire complex. In addition, a natural gas service feeds the community hall furnace as well as the radiant heaters in the arena.

4.2 Electrical Consumption, Demand and Cost

.1 General

Electrical consumption, demand and cost for the year ended March, 1983, is presented in Table 1 at the end of this section. The tabulated values are also presented graphically.

.2 Electrical Consumption and Cost

From the information available on energy use in the facility, we have established the following Table. The Table is based on the present building operation as outlined in Section 1.2 - Building Occupancy and Use, and is intended to represent energy usage prior to implementation of retrofit projects.

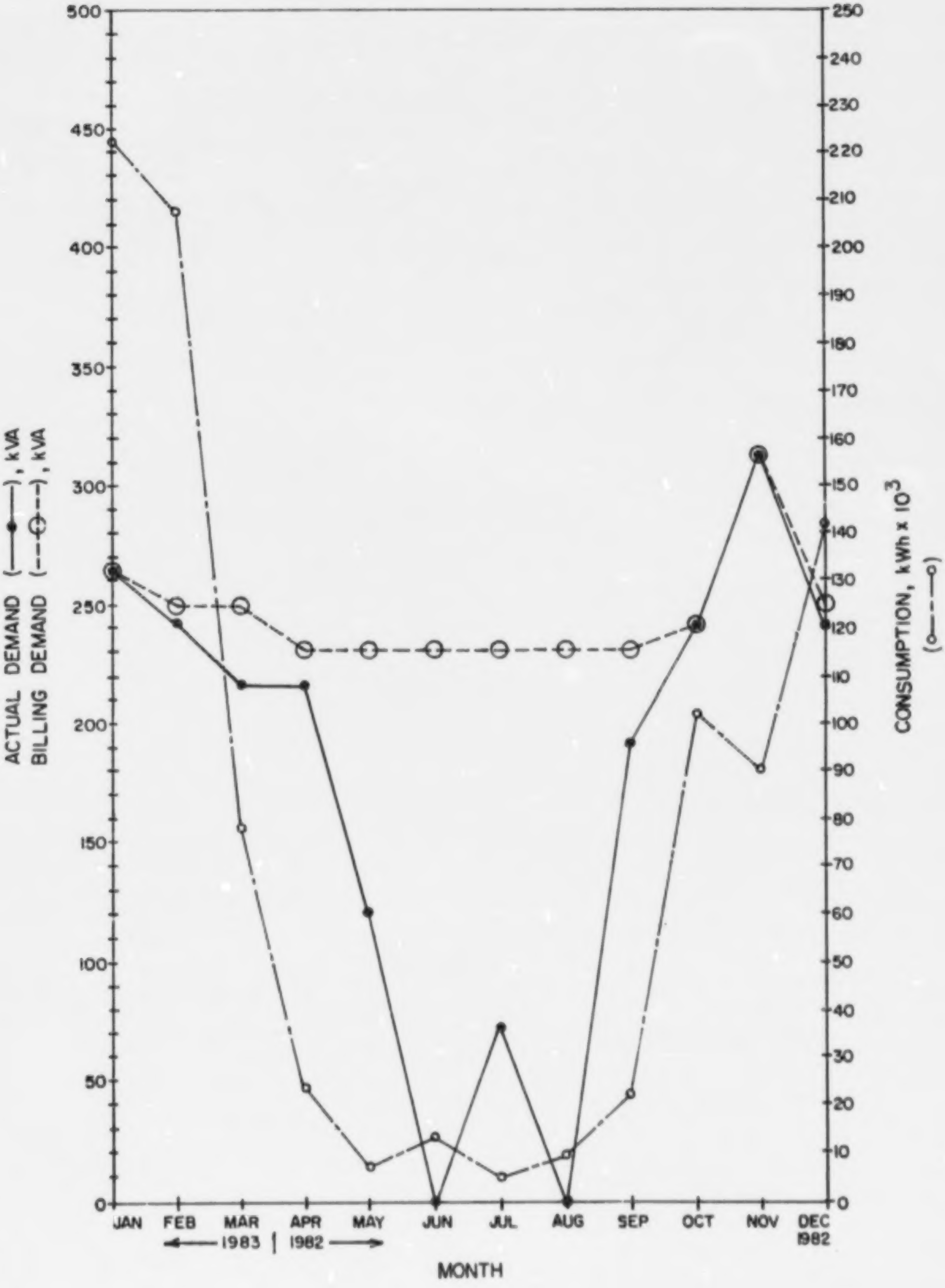
	Annual Consumption (kWh)	% of Total	*Annual Cost ($)
Ice Plant - Arena	214,620	23	5,945
Heating - Arena	18,710	2	518
- 2-Level	240,896	25	6,673
- Hall	107,585	12	2,980
Lighting - Arena	127,676	14	3,536
- 2-Level	53,104	6	1,471
- Hall	6,148	1	170
Kitchen - Hall	14,700	2	407
Water Heating - Flood & Domestic	83,145	9	2,303
Other Miscellaneous	53,816	6	1,491
Totals	920,400	100	25,494

* The annual cost is based on 1982 electrical rates and includes the cost for both consumption and demand.

TABLE 1

ELECTRICAL CONSUMPTION, DEMAND AND COST FOR YEAR ENDING JANUARY, 1983

	Electrical Consumption (kWh)	Electrical Demand (kVA) Actual	Electrical Demand (kVA) Billed	Electrical Cost ($)	Electrical Consumption (GJ)
April, 1982	22,800	216	230	1,424	82
May	7,200	120	230	1,153	26
June	13,200	-	230	1,311	48
July	4,800	72	230	1,078	17
August	9,600	-	230	1,228	35
September	21,600	192	230	1,410	78
October	102,000	240	240	2,543	367
November	90,000	312	312	2,623	324
December	141,600	240	250	2,921	510
January, 1983	222,000	264	264	3,936	799
February	207,600	240	250	3,697	747
March	78,000	216	250	2,173	281
Total for Year	920,400			25,497	3,314



ELECTRICAL DEMAND AND CONSUMPTION
THE YELLOWHEAD CENTRE

SECTION 4 - ENERGY CONSUMPTION & COST

4.1 General

The Roblin and District arena is an all-electric building with the exception of a gas service for flood water heating.

There is only one electric service entrance for the building. This is a demand service from which the adjacent swimming pool is also fed.

4.2 Electrical Consumption, Demand and Cost

.1 General

Electrical consumption, demand and cost for the year ended April 18, 1983, is presented in Table 1 at the end of this section. The tabulated values are also presented graphically.

.2 Electrical Consumption and Cost

From the information available on energy use in the facility, we have established the following Table. The Table is based on the present building operation as outlined in Section 1.2 - Building Occupancy and Use, and represents energy usage prior to implementation of retrofit projects.

	Annual Consumption (kWh)	% of Total	*Annual Cost ($)
Ice Plant - Arena	123,507	34	6,391
Heating - 2-Level	171,403	46	8,870
- Tractor Room	3,363	1	174
Lighting - 2-Level	13,068	4	676
- Arena	55,459	15	2,870
Totals	366,800	100	18,981

* The annual cost is based on 1982 electrical rates and includes the cost for both consumption and demand.

.3 Electrical Demand

From the available information, a breakdown of the building electrical demand has been established, as indicated below.

The peak demand of 260 kVA for this winter season was established in December of 1982.

	Monthly kVA
Ice Plant - Arena	93
Heating - 2 Level	94
- Ice Plant	5
- Tractor Room	5
Lighting - Arena	27
- 2 Level	12
- Other	5
Other Miscellaneous Loads	19
	260 kVA

From the breakdown shown, it is apparent that the major contributors to high electrical demand are the ice plant and electric heat. A reduction in this peak can be expected as a result of recommendations in Section 5 of this report.

An obvious savings in electrical demand has resulted from the disconnection of radiant heating panels.

4.3 Gas Consumption and Cost

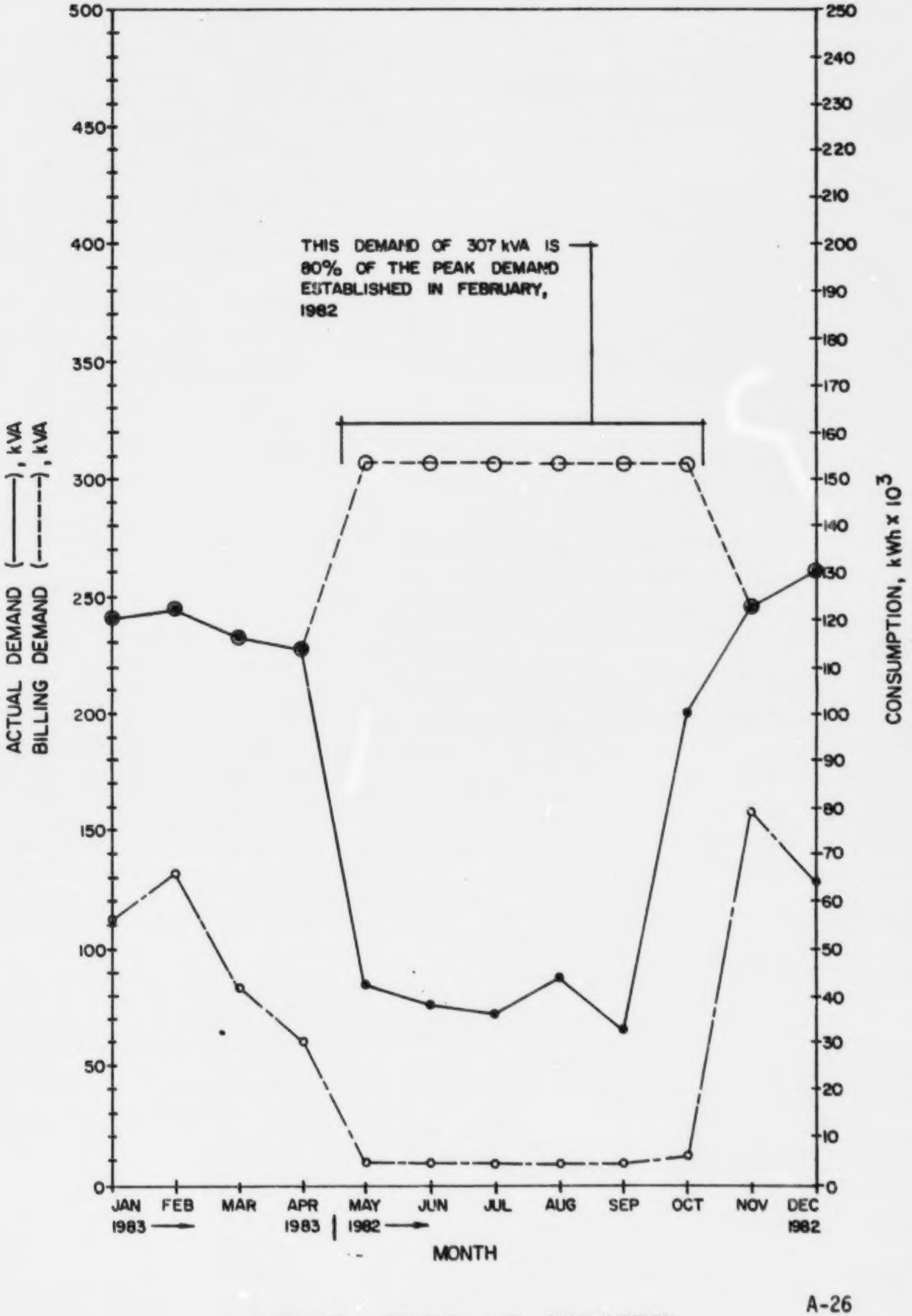
Gas consumption and cost on a monthly basis was not available at the time of this survey. However, the total cost for natural gas for ice flood water heating for the last half of the 1982/83 season was $699.

TABLE 1

ELECTRICAL CONSUMPTION, DEMAND AND COST FOR YEAR ENDING JANUARY, 1983

	Electrical Consumption (kWh)	Electrical Demand (kVA) Actual	Electrical Demand (kVA) Billed	Electrical Cost ($)	Electrical Consumption (GJ)
May, 1982	4,800	84	307	1,384.07	17
June	4,800	76	307	1,384.07	17
July	4,800	72	307	1,384.07	17
August	4,800	88	307	1,384.07	17
September	4,800	64	307	1,384.07	17
October	5,600	200	307	1,407.83	20
November	79,600	244	244	2,050.23	287
December	63,200	260	260	1,942.55	228
January, 1983	56,000	240	240	1,766.91	202
February	66,000	244	244	1,897.91	238
March	42,000	232	232	1,572.11	151
April, 1983	30,400	228	228	1,423.19	109
Total for Year	366,800	2,032	3,290	18,981.08	1,320

NOTE: Consumption figures above are estimated from actual as a result of power also supplied to pool and barn.



ELECTRICAL DEMAND AND CONSUMPTION
ROBLIN AND DISTRICT ARENA

SECTION 4 - ENERGY CONSUMPTION AND COST

4.1 General

Energy consumption and costs presented in this section were taken from a government audit performed on the facility in May of 1982. For the year ended February, 1982, the annual electricity and natural gas consumption in the building totalled 1,377,640 kWh for an annual energy cost of $33,390.

4.2 Electrical Consumption, Demand and Cost

.1 General

Electrical consumption, demand and cost for the year ended February 23, 1982, is presented in Table 1 at the end of this section. The tabulated values are also presented graphically.

.2 Electrical Consumption and Cost

From the information available on energy use in the facility, we have established the following Table. The Table is based on the present building operation as outlined in Section 1.2 - Building Occupancy and Use, and represents energy usage prior to implementation of retrofit projects.

		Annual Consumption (kWh)	% of Total	*Annual Cost ($)	% of Total
Ice Plant	- Arena	250,800	40	9,716	41
	- Curling Rink	115,980	19	3,485	15
Lighting	- Arena	91,280	15	3,277	14
	- Curling Rink	65,880	11	2,485	10
Other	- Arena	58,240	9	2,647	11
	- Curling Rink	42,380	6	2,104	9
Totals		624,560	100	23,714	100

* The annual cost is based on 1982 electrical rates and includes the cost for both consumption and demand.

.3 Electrical Demand

Of the three electrical services entering the complex two are demand services, one for each ice plant.

Recommendations for combining meters, power factor correction and demand control given in Section 5 will have the overall benefit of reducing annual costs.

4.3 Natural Gas Consumption

.1 General

Natural gas consumption and cost for the year ending February , 1982, is presented in Table 2 at the end of this section. The tabulated values are also presented graphically.

.2 Natural Gas Consumption and Cost

From the information available on energy use in the facility, we have established the following Table. The Table is based on the present building operation as outlined in Section 1.2 Building Occupancy and Use, and represents energy usage prior to implementation of retrofit projects.

	Annual Consumption (mcf)	% of Total	*Annual Cost ($)	% of Total
Furnaces & Domestic Hot Water	1,144	44	4,290	44
Rink Flooding Water	460	18	1,826	19
2nd Floor Meeting Room	18	1	87	1
Curling Rink Furnaces	949	37	3,473	36
Totals	2,571	100	9,676	100

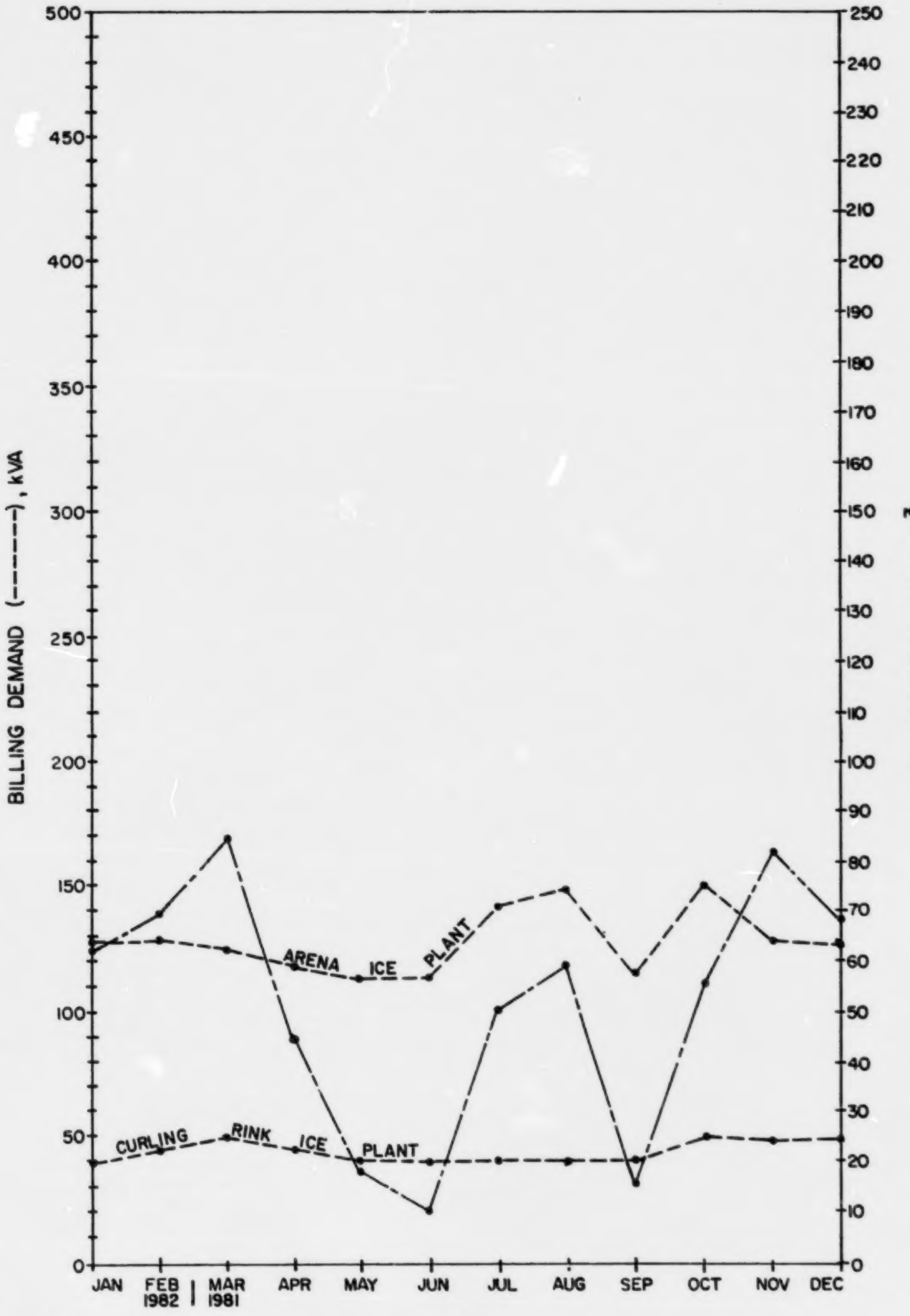
* Annual cost is based on 1982 Natural Gas rates.

TABLE 1

ELECTRICAL CONSUMPTION, DEMAND AND COST FOR YEAR ENDING FEBRUARY, 1982

	Electrical Consumption (kVA)	Electrical* Demand kVA Billed	Electrical Cost ($)	Electrical Consumption (GJ)
March	85,420	172	2,727	308
April	45,320	160	1,756	163
May	17,240	151	1,109	62
June	10,000	151	844	36
July	51,450	179	1,810	185
August	59,580	187	1,913	214
September	16,290	151	1,061	59
October	56,040	196	2,364	202
November	82,700	175	2,580	298
December	68,060	172	2,484	245
January	62,840	164	2,507	226
February	69,620	172	2,559	251
Total for Year	624,560	2,030	23,714	2,249

* Total for 2 demand meters.



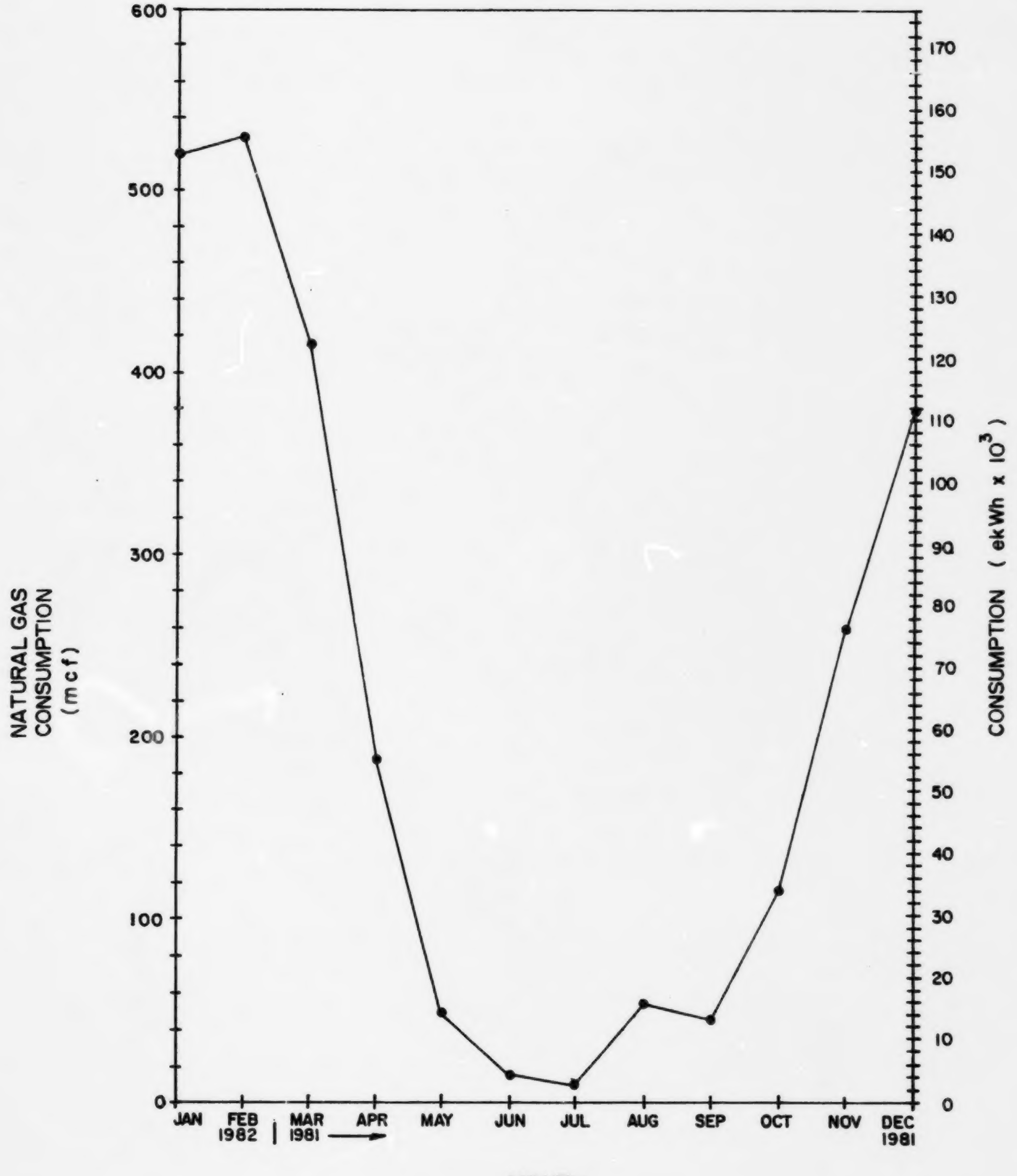
ELECTRICAL DEMAND AND CONSUMPTION
CARMAN COMMUNITY ARENA

TABLE 2

NATURAL GAS CONSUMPTION AND COST FOR THE YEAR ENDING FEBRUARY, 1982

	Gas Consumption (mcf)	Gas Cost ($)	Gas Consumption (GJ)
March *	415	1,562	435
April	187	704	196
May	50	190	52
June	15	57	16
July	12	48	13
August	55	217	58
September	46	176	48
October	115	439	121
November	260	981	272
December	378	1,422	396
January	511	1,913	535
February	529	1,976	554
Total for Year	2,573	9,685	2,696

* Estimated



FUEL CONSUMPTION
CARMAN COMMUNITY ARENA

APPENDIX B

APPENDIX B

MANUFACTURERS' LITERATURE

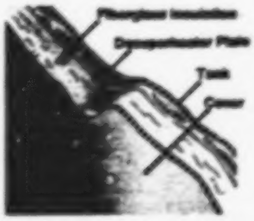
Part Numbers
4016000 freon connections
4016100 Ammonia connections

THERMA-STOR® II
HEAT RECOVERY SYSTEM

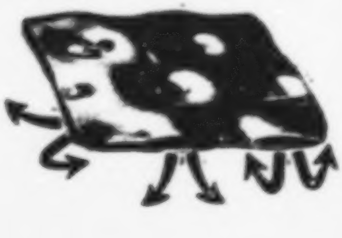
SPECIFICATION INFORMATION

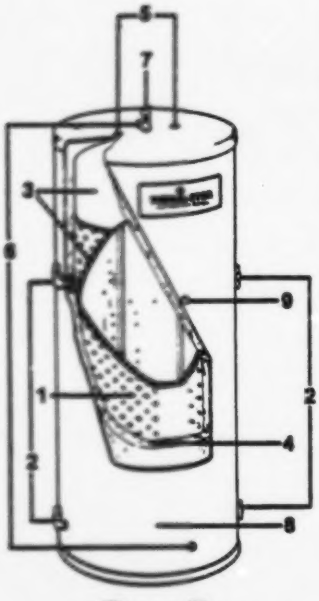
CONSTRUCTION SPECIFICATIONS . . .

1. Vertical dual circuit desuperheater plate welded and expanded for internal refrigerant passage.
2. 1-1/8" O.D. refrigerant inlets and outlets.
3. Industrial glass lined hot water storage tank. (1-1/4" Male Npt refrigerated inlets and outlets on Ammonia unit).
4. 1" Fiberglass insulation.
5. Dual anode protection against corrosion for extended tank life.
6. Water inlet and high-temp. outlet are 1-1/4" male Npt.
7. 150 Psi and 210°F. pressure/temperature relief valve.
8. Attractive water-resistant outer wrapper.
9. Water temperature control connection 3/4" Npt.



Therma-Stor® plate design, with rapid, free flowing paths for freon gas (which carries the hot refrigerant waste heat), promotes excellent waste heat transfer throughout the tank.





OTHER FEATURES AND SPECIFICATIONS:

- Size 25" dia. 65" height, **370 Lb. in weight.
- 119 gallon nominal water capacity.
- Rated for 400 Psi refrigerant operating pressure.
- 150 Psi maximum operating water pressure.
- Double wall protection between refrigerant and water.
- U.L. Listed
- CSA Approved

OPERATION . . .

Therma-Stor® II produces and stores hot water by transferring the waste heat of a refrigeration system to cold water. This cost-efficient alternative for producing hot water fits any existing refrigeration system and is designed to improve that system's efficiency at the same time. Hot water production is dependent on the evaporator load, run time of the compressor, and water usage.

APPLICATION SPECIFICATION . . .

Therma-Stor® II can accommodate evaporating loads of up to 25 tons total when utilizing R-22 and R-502, 30 tons on R-717 and 12-ton total on R-12. The individual Therma-Stor® II circuits (split 50/50) can be connected to proportional individual compressors or ganged in multiples for larger tonnages. Considering the limited condensing capacity, ThermaStor's are not intended to substitute the need for air or water cooled condensers. Discharge line mufflers must be installed on all systems incorporating semi-hermetic or open-type compressors. These mufflers are to be sized in accordance with the refrigeration tonnage being supplied to the Therma-Stor®.

WATER TEMPERATURE CONTROL . . .

A check of the system's operating pressures and temperatures is recommended. Should the discharge gas temperature leaving the compressor reach 210°F, provisions to bypass the hot gas around the Therma-Stor® and directly on to the conventional condenser should be incorporated in the system piping. This provision can be accomplished with the use of an aqua-stat in conjunction with hot gas bypass valves and other arrangements. A 3/4" Npt female coupling is provided near the top of the Therma-Stor® shell for the recommended water temperature controllers.

Capillary tube systems are not normally recommended to be used with Therma-Stor®. For special considerations, please contact the factory.

DEC DAIRY EQUIPMENT CO.
A Division of DEC International, Inc.

Lit. No. SP-134B
Effective 1/83

WATER HEATING CHART

HOW MUCH HOT WATER DO YOU USE?

Chart #1 shows the water temperature rise you can expect at any of the given compressor outputs and water usages.

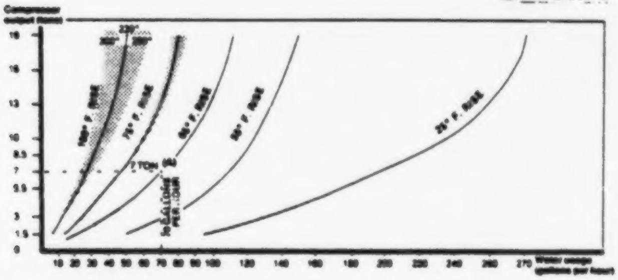
FIRST, determine your hot water usage in gallons/hour (this can be estimated or measured).

SECOND, determine your compressor(s) output (in tons).

THIRD, extend the compressor output line until it intersects the water usage line on the 'water heating chart'.

FOURTH, estimate the water temperature rise fro. the chart at the point of intersection.

CHART 1



Temperatures given are based on cold water supply up to 65°F.

EXAMPLE

Given
- **7 Ton compressor(s) output**
- **70 Gallon/hour water usage**
- **65° Cold water supply temperature**

Then	**65°F—Cold water supply temp.**
Adding	**+65°F—Estimated water temperature rise (refer to A on Chart #1)**
Equals	**130°F—Total high-temp. water output**

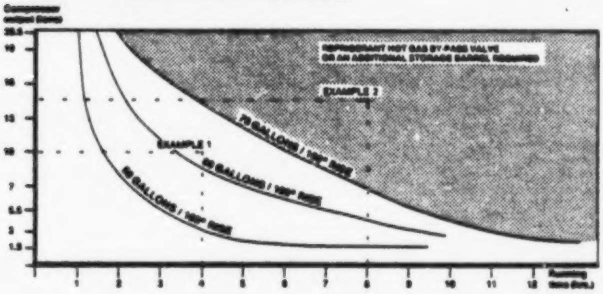
As you can see, with those given conditions, one Therma-Stor® II can heat 70 gallons of 65° water to 130°F. If hotter water is desired, recalculate using two Therma-Stor® II's (this doubles the heating plate area).

Chart #2 shows quantity of 100° rise water you can expect from different combinations of compressor output and running time (hours).

Any combination of capacity and running time that falls into the shaded area requires a refrigerant hot gas by-pass valve or an additional storage tank to avoid overheating water.

GALLONS OF 100° F RISE WATER AVAILABLE

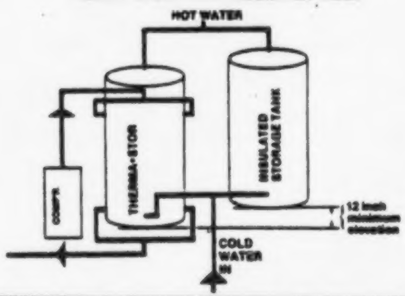
CHART 2



EXAMPLE 1 shows the amount (in gallons) of hundred degree water available at the end of 4 hours.

EXAMPLE 2 shows that the amount of hot water available has exceeded the 70-gallon limit. If the amount of hot water required during the 8 hours of operation is approximately 70 gallons, a hot gas bypass valve is recommended. If more than 70 gallons of hot water is required per batch, an additional storage barrel is recommended.

THERMA-STOR® WITH INSULATED TANK

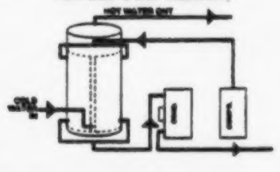


HOT WATER
THERMA-STOR
INSULATED STORAGE TANK
COMP.
12 inch minimum elevation
COLD WATER IN

See installation instructions for further details.

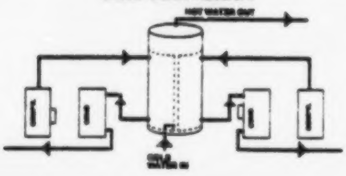
BASIC THERMA-STOR® HRS INSTALLATIONS

SINGLE COMPRESSOR



HOT WATER OUT
COLD WATER IN

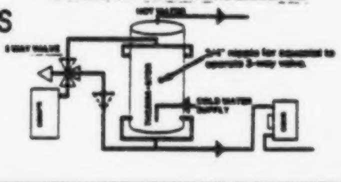
DUAL COMPRESSOR



HOT WATER OUT
COLD WATER IN

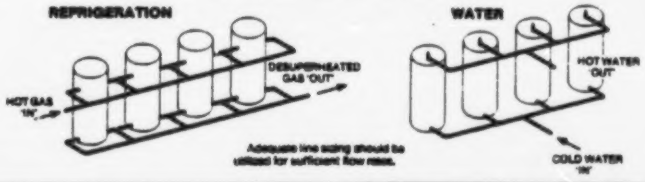
TYPICAL THERMA-STOR® HRS PIPING

HOT GAS BY-PASS VALVE EXAMPLE



HOT WATER
3-WAY VALVE
3/4" nipple for aquastat to operate 3-way valve.
THERMA-STOR
COLD WATER SUPPLY

MULTIPLE THERMA-STOR® SYSTEMS



REFRIGERATION
WATER
HOT GAS 'IN'
DESUPERHEATED GAS 'OUT'
HOT WATER 'OUT'
COLD WATER 'IN'

Adequate line sizing should be utilized for sufficient flow rates.

THERMA-STOR® HEAT RECOVERY SYSTEM

CHIL-CON
PRODUCTS LIMITED

54 Spalding Drive, Brantford, Ontario
Telephone 519-759-3010 Telex:061-81195

BULLETIN: CE-2
Effective: Dec.15/76
Page 1.

ENGINEERING DATA
DIRECT EXPANSION
TYPE EF SHELL & TUBE LIQUID CHILLERS

INDEX

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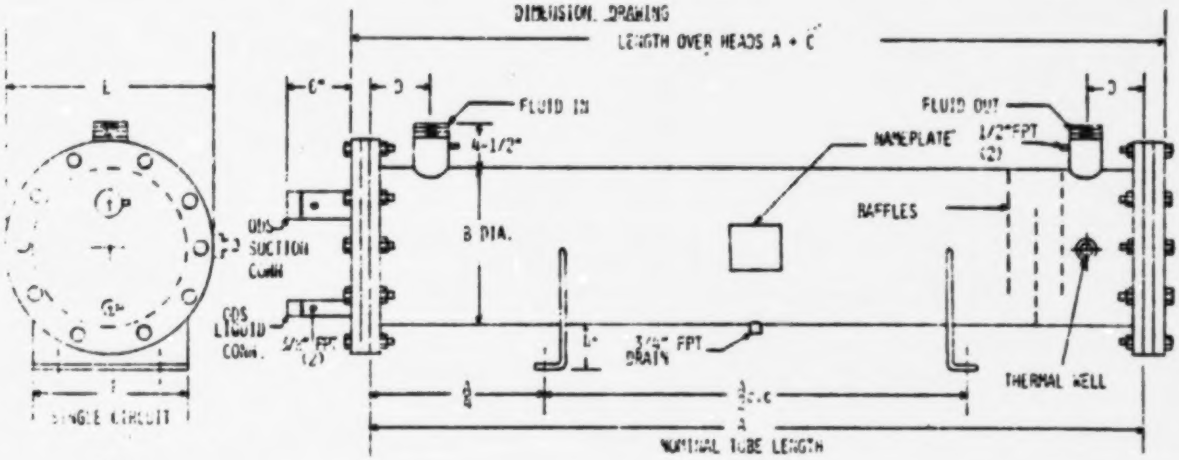
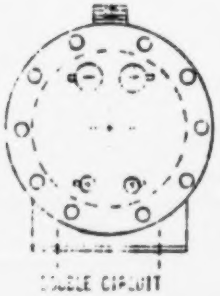
5. 8", 10" dia. capacities
Page 6. 12", 14" dia. capacities
7. 16", 18" dia. capacities
8. 20" dia.capacities & P.D.curve
9. physical data table
10. specifications


DIMENSION DRAWING
LENGTH OVER HEADS A + C
E
C"
D
FLUID IN
4-1/2"
FLUID OUT
1/2" FPT (2)
NAMEPLATE
BAFFLES
ODS SUCTION CONN
B DIA.
ODS LIQUID CONN.
1/2" FPT (2)
E
3/4" FPT DRAIN
THERMAL WELL
A/4
A/2 ± C
A
NOMINAL TUBE LENGTH
F
SINGLE CIRCUIT


DOUBLE CIRCUIT

ALL DIMENSIONS IN INCHES

SHELL DIA. NOMINAL B O.D.	C	D APPROX.	E	F
5-9/16	2-1/4	2-1/16	8-5/8	6-5/8
6-5/8	2-3/4	2-5/8	10	6-5/8
8-5/8	3-1/4	3-3/8	12	8-5/8
10-3/4	3-1/4	4-1/8	14-5/8	10-3/4
12-3/4	3-1/4	4-1/8	16-5/8	12-3/4
14	4-1/4	4-3/4	18-3/8	14
16	5-1/4	5-13/16	20-7/8	16
18	5-1/4	5-13/16	22-7/8	18
20	5-1/4	5-13/16	24-7/8	20

IF ARMAFLEX INSULATION ORDERED. ADD APPROX. 1-1/2" TO DIM B.E. AND A + C

SPECIFICATIONS
TYPE EF LIQUID CHILLERS

GENERAL: Straight-through tube construction with removable heads at both ends. Head passes are designed to ensure refrigerant velocity will return oil, combined with minimum refrigerant side pressure drop.

CODES: Constructed in accordance with Section VIII of the 1974 ASME code and Canadian Standards Association B-51 Code. Design registered with The Ministry of Labour in all Canadian Provinces.

WORKING PRESSURES:
Shell side is 150 PSI, tube side is 150 PSI.

SHELL: Steel pipe A-53 Grade "B".

HEADS: Fabricated ring & cover plate type, with head pass divisions, from SA-285 Grade C steel.

TUBES: 5/8"OD seamless, type B-111 deoxidized copper, parallel roller expanded into tube sheets.
Internally finned with notched aluminum multiple flanged extrusion, mechanically bonded internally for full contact with inside of tubes.

TUBE SHEETS:

Carbon steel plate SA-285 Grade "C" flange quality.
Tube holes are reamed and double grooved.

BAFFLES: Heavy gauge steel, located with spacers and tie rods at designed spacing for proper liquid velocity with minimum liquid side pressure drop.

CONNECTIONS:

Liquid connections 3" and smaller are MPT steel pipe. Above 3", connections are provided with 150 lb. ASA steel flanges. Refrigerant connections are ODF as standard.

MOUNTING LEGS:

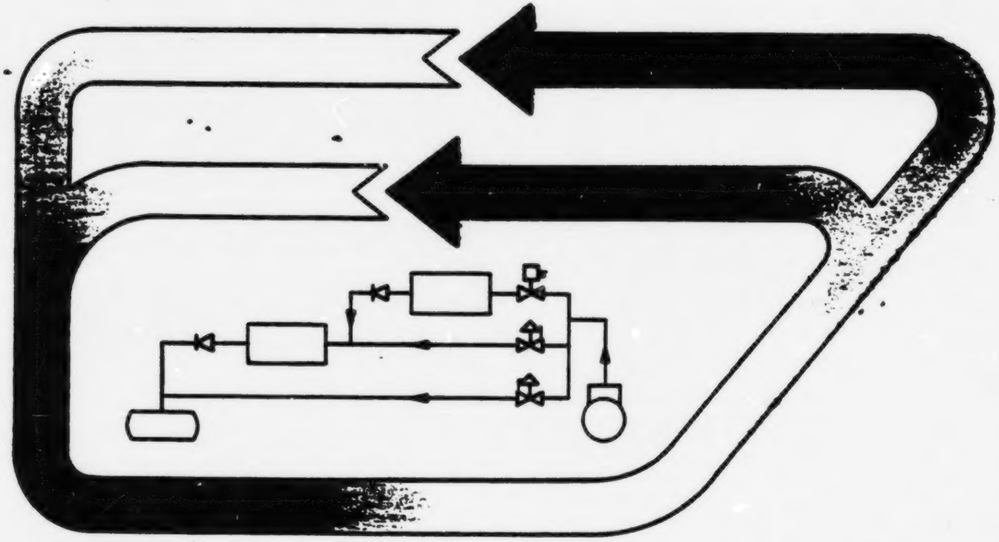
Heavy gauge formed steel, welded to shell.

FINISH: Painted with grey-blue prime coat.

NOTE: To meet delivery schedules specifications of material may be changed without notice. However substitute material will always be in accordance with above codes.

Chil-Con Products Limited liquid chillers are guaranteed free of defects in material and workmanship for one year from date of shipment. Vessels found by factory inspection to be defective will be repaired free of charge F.O.B. Factory. No liability will be assumed for charges, losses or damage, consequential or otherwise.

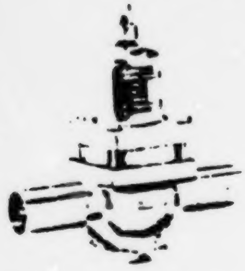
REFRIGERATION CONTROL VALVES
FOR
HEAT RECLAIM



FLO·CON Division

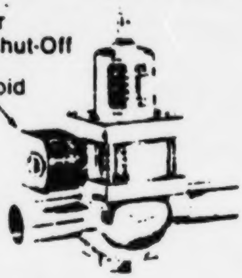
REFRIGERATING SPECIALTIES COMPANY
[illegible] So. 25th Ave., Broadview, Illinois 60153 U.S.
[illegible]

TYPICAL FLO•CON HEAT RECLAIM CONTROL VALVES



Type A7A
⅝"-1⅛" ODS
Type A7A1 similar
1⅜"-1⅝" ODS
Inlet Regulator

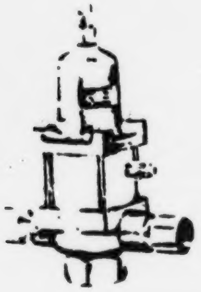
Type A7AL
⅝"-1⅛" ODS
Type A7A1L
Similar
1⅜"-1⅝" ODS
Differential
Pressure Regulator



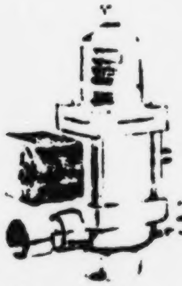
Inlet Regulator
with Electric Shut-Off

Pilot Solenoid

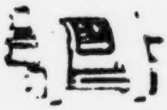
Type A7AS
⅝"-1⅛" ODS
Type A7A1S similar
1⅜"-1⅝" ODS



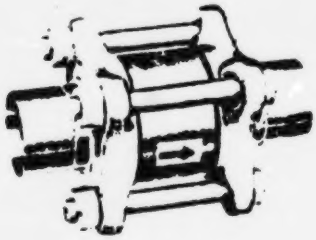
Type A9E
⅝", ⅞" & 1⅛"ODS
Outlet
Regulator



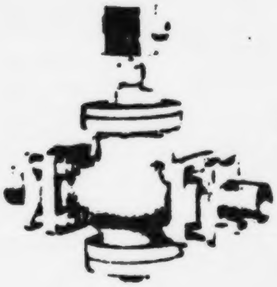
Type A9SE
⅝", ⅞" & 1⅛"ODS
Outlet Regulator
with Electric
Shut-Off
Pilot Solenoid



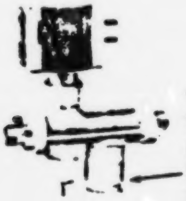
Type CK4A-2 (½")
Check Valve



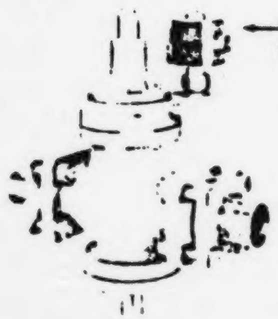
Type CK4A-8 (2")
Check Valve



Type S4A
(¾"-3")
Solenoid Valve

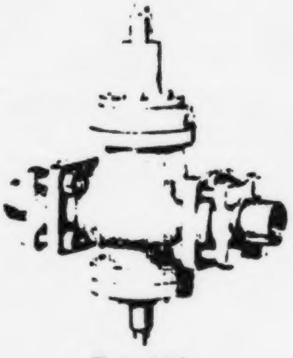


Type S6N
Type S8F
(½")
Strainer
Solenoid Valve

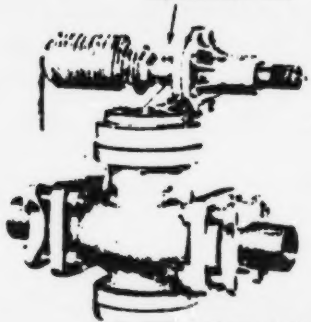


Pilot
Solenoid

Type A4AS
(¾"-4")
Inlet Regulator
with Electric Shut-Off



Type A4A
(¾"-4")
Inlet
Regulator



Temperature
Operated Pilot

Type A4AT
(¾"-4")
Temperature
Controlled
Inlet Regulator

(Type A4AOT
Temperature
Controlled
Outlet Pressure
Regulator is
similar.)

Refrigerating Specialties Company
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Printed In U.S.A.

EXAMPLES OF VALVE SELECTION.

The following examples are for valves in Figures 2 to 5, each as might be selected for the same R-502, hermetic refrigeration system. All examples use the following design conditions:

Description of System Operation	Suction Temp.	Condensing Temp.	Compressor Refrigeration Capacity
Design Cooling Conditions	−20°F	90°F	9.3 Tons
Heat Reclaim Conditions	−20°F	120°F	6.8 Tons

The Heat Reclaim requirement can be equal to the maximum available from the refrigeration system under certain conditions—which is what has been done in Figures 2 to 4—or, it might be some smaller amount, as in Figure 5.

VALVE SELECTIONS FOR FIGURE NO. 2:

Valve	Refrigeration Load	Condensing Temperature	Valve Size and Type	Table Used
C-2	6.8 Tons	120°F	¾" Port CK4A-3, specify line size	C
D-1	9.3 Tons	90°F	1⅛" A7A1, RangeD	D
D-2	6.8 Tons	120°F	1" Port S4A, specify line size and volts	D

VALVE SELECTIONS FOR FIGURE NO. 3:

Valve	Refrigeration Load	Condensing Temperature	Valve Size and Type	Table Used
B	9.3 Tons	90°F	⅞" A9, RangeB	B
C-1	9.3 Tons	90°F	¾" Port CK4A-3; specify line size	C
C-2	6.8 Tons	120°F	¾" Port CK4A-3; specify line size	C
D-1	9.3 Tons	90°F	1⅛" A7A1, RangeD	D
D-2	6.8 Tons	120°F	1" Port S4A; specify line size and volts	D

VALVE SELECTIONS FOR FIGURE NO. 4:
(C-1 and C-2 same as for Figure No. 3)

Valve	Refrigeration Load	Condensing Temperature	Valve Size and Type	Table Used
B	9.3 Tons	90°F	⅞" A9, RangeB	B
*D-1	6.8 Tons	120°F	⅞" A7A, RangeD	D
D-2	6.8 Tons	120°F	1" Port S4A; specify line size and volts	D
D-11	9.3 Tons	90°F	1⅛" A7A1S, RangeD specify volts	D

VALVE SELECTIONS FOR FIGURE NO. 5:
(Assume each Heat Reclaim Condenser load is 50%
of system capacity or 3.4 Tons.)

Valve	Refrigeration Load	Condensing Temperature	Valve Size and Type	Table Used*
A-2 A-3	3.4 Tons	120°F	⅝", 49% A7A, RangeD	A
B	9.3 Tons	90°F	⅞" A9, RangeB	B
C-1	9.3 Tons	90°F	¾" Port CK4A-3; specify line size	C
C-2 C-3	¾ Tons	120°F	½" Port CK4A-2; specify line size	C
*D-1	6.8 Tons	120°F	⅞" A7A, RangeD	D
D-2 D-3	3.4 Tons	120°F	¾" Port S4A, specify line size and volts	D
D-11	9.3 Tons	90°F	1⅛" A7A1S, Range D, specify volts	D

*D-1 will handle only excess load from Heat Reclaim, thus the next size smaller valve than that size required for the full load can be normally used

TYPICAL SYSTEM WITH PARALLEL CONDENSERS

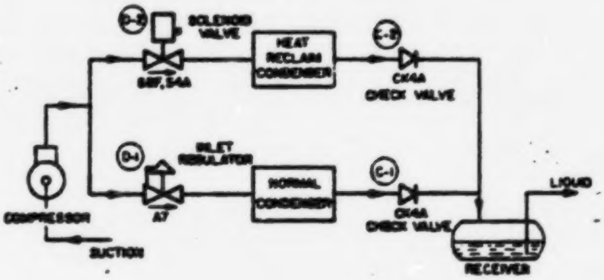
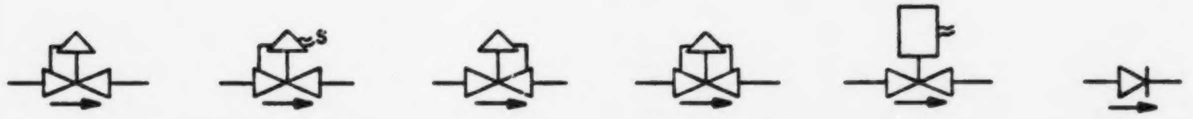


Figure 6.

Any of the systems illustrated in Figures 2 to 5 may also be piped with the condensers in parallel instead of in series. Parallel condensers may reduce the amount of piping required. Precautions must be taken, however, to be sure of complete condensation in the Heat Reclaim condenser. For example, if an air heating condenser is used, a scheduled maintenance program must keep the air filters and condenser face area clean and free of debris; if a water heating condenser is used, a flow switch should be installed in the water line to measure an adequate flow before the condenser can be used.

CONTROL VALVE SYMBOLS and FUNCTIONS



INLET PRESSURE REGULATOR
(Opens on a rise in inlet pressure. Closes when inlet pressure is below set-point.)

INLET PRESSURE REGULATOR WITH ELECTRIC SHUT-OFF
(Opens on a rise in inlet pressure when energized. Closes when inlet pressure is below set-point or when de-energized.)

OUTLET PRESSURE REGULATOR
(Opens on a drop in outlet pressure. Closes when outlet pressure is above set-point.)

DIFFERENTIAL PRESSURE REGULATOR
(Opens on a rise in pressure difference. Closes when pressure difference is below set-point.)

SOLENOID VALVE
(Opens when energized; closes when de-energized.)

CHECK VALVE
(Permits flow in one direction only.)

Figure 7

Table II
APPROXIMATE HEAT REJECTION FACTORS†
For R-12, R-22 and R-502

Saturated Suction Temperature	Saturated Condensing Temperature				
Hermetic Compressors	90°F	100°F	110°F	120°F	130°F
−40°F	1.85	1.92	2.00	2.13	2.27
−20°F	1.56	1.64	1.69	*1.82	1.96
0°F	1.41	1.45	1.52	1.61	1.72
+20°F	1.32	1.35	1.41	1.47	1.56
+40°F	1.25	1.28	1.33	1.39	1.43
Open Compressors	90°F	100°F	110°F	120°F	130°F
−40°F	1.42	1.47	1.54	1.59	1.67
−20°F	1.32	1.37	1.41	1.45	1.52
0°F	1.25	1.28	1.32	1.35	1.41
+20°F	1.18	1.20	1.23	1.28	1.32
+40°F	1.11	1.15	1.18	1.20	1.23

†Net Refrigeration Effect × Factor = Approximate Heat Rejected.

The factors listed are for reciprocating compressors only and are based on suction gas entering the compressor at the following conditions:

R-12, R-502; 15°F superheat for 40°F, 20°F and 0°F saturated suction.
R-12, R-502; 55°F superheat for −20°F saturated suction.
R-12, R-502; 75°F superheat for −40°F saturated suction.
R-22; 15°F superheat for 40° to −40°F saturated suction.

For other amounts of superheat the Heat Rejection Factors should be changed by the following approximate percents: For each 20°F increase in superheat, increase the factor by 5%; for each 20°F decrease in superheat, decrease the factor by 5%.

The factors can be used to find heat rejected when the refrigeration effect is known, or, conversely, to find the refrigeration effect required to produce a known amount of rejected heat, as illustrated by the following sample problems:

1. How much heat can be rejected from a 6.2 ton, R-502 system operating at 120°F saturated condensing temperature, −20°F saturated suction temperature and 55°F suction gas entering the compressor.

   Solution: 6.2 tons × *1.82 × 12,000 Btu per hr per ton = 135,400 Btu per hr. If the suction gas entering the compressor is 35°F instead of 55°F, the factor will be reduced by 5%, or 1.82 × 0.95 = 1.73 and the heat rejected will be 6.2 tons × 1.73 × 12,000 Btu per hr per ton = 128,600 Btu/hr.

2. What is the approximate net refrigeration effect which will deliver 135,400 Btu per hour of rejected heat at 120°F saturated condensing temperature in an R-502 system, using a hermetic compressor which is operating at −20°F saturated suction temperature with 55°F suction gas entering the compressor?

   Solution: $\dfrac{135.400\ \text{Btu per hr}}{{}^{*}1.82 \times 12{,}000\ \text{Btu per hr per ton}} = 6.2\ \text{tons}$

ADDITIONAL ENGINEERING INFORMATION

The information in this manual is necessarily broad in scope and general in nature. However, a tremendous variety of Heat Reclaim applications are possible and some may require other valve variations, ranges or combinations not fully described in these pages. For valve and regulator selection and sizing information to suit an unusual problem or system idea, send complete details by letter, wire, or telephone.

Additional Flo•Con literature covering specific valves and applications is available from the factory. Write or call for assistance in valve selection or for any of the Bulletins listed below:

Valve Type and Function	Bulletin Description	Bulletin Number
A7 Inlet Regulators	Installation, Service and Parts Information	25-91
A9 Outlet Regulators	Installation, Service and Parts Information	25-95
CK4A Check Valves	Installation, Service and Parts Information	50-07
S4A Solenoid Valves	Installation, Service and Parts Information	30-04
S8F Solenoid Valve	Installation, Service and Parts Information	30-91
All Types	Condenser Pressure Control Application Manual	CPC
A9 Outlet Regulators	Hot Gas Bypass	BYG
All Types	Flo-Con Condensed Catalog	610
All Types	Refrigerating Specialties Company Safety Bulletin	RSB

SAFE OPERATION

The Heat Reclaim or Heat Recovery system diagrams shown and described in this bulletin are intended only to illustrate typical applications of Refrigerating Specialties Company and Flo•Con control valves. These diagrams are schematic suggestions only and do not attempt to cover other important design considerations such as pipe sizing and configuration, selection and placement of major components (such as compressor, condenser, evaporator and receiver), patents, safety and limit controls or choice of refrigerant or oil. For these reasons, the use of Refrigerating Specialties Company control valves illustrated in this bulletin does not lead to or guarantee reliability, satisfaction or safety of the resulting system unless proper engineering and experience is used for the complete system.

Any installation must follow known and accepted industry safety practices and various code or legal requirements. The current edition of Refrigerating Specialties Company Safety Bulletin RSB should be read before installing or servicing any Refrigerating Specialties Company Control Valves. A copy is shipped with every valve and free copies are available on request from the factory.

Tons TABLE C Tons
For Check Valves Used at Condenser Outlet

Valve C Capacities in **Tons** of evaporator capacity at 0°F
See Figures 2 to 5. Ratings are for **Condensing Temperatures** shown and **1 psi Pressure Drop.**

Size	Type	90°F	110°F	130°F
CHECK VALVES "C"				
½"	CK4A-2	8.0	7.1	6.2
¾"	CK4A-3	17	15	13
1"	CK4A-4	31	27	24
1¼"	CK4A-6	45	40	35
2"	CK4A-8	110	96	84
2½"	CK4A-9	170	150	130
3"	CK4A-0	260	230	200
4"	CK4-16	500	440	380
CHECK VALVES "C"				
½"	CK4A-2	11	9.5	8.3
¾"	CK4A-3	22	20	17
1"	CK4A-4	41	36	32
1¼"	CK4A-6	60	53	46
2"	CK4A-8	140	130	110
2½"	CK4A-9	220	200	170
3"	CK4A-0	350	310	270
4"	CK4-16	680	590	510
[illegible]				

[illegible] 10°F [illegible] leaving 0°F evaporator

OTHER EVAPORATOR TEMPERATURES [illegible] Tables A B C [illegible]

TABLE III
Evaporator Temperature

Ref't	−40°F	−20°F	0°F	20°F	40°F
R-12	0.90	0.95	1.00	1.04	1.08
R-22	0.94	0.97	1.00	1.03	1.06
R-502	0.88	0.94	1.00	1.05	1.10

Tons TABLE D Tons
For Control Valves Used at Condenser Inlet

Valve D Capacities in **Tons** of evaporator capacity at 0°F
See Figures 2 to 5. Ratings are for **Condensing Temperatures** and **Pressure Drops** shown

Size	Type	90° to 130°F	
		2 psi	5 psi
INLET REGULATORS "D"			
⅝"*	A7A	0.98	1.6
⅞"	A7A	2.0	3.2
⅞" & 1⅛"	A7A	2.8	4.5
1⅛"	A7A1	5.7	8.9
1⅜" & 1⅝"	A7A1	6.2	9.8
1⅝"	A72	10	16
2⅛" & 2⅝"	A72	16	24
SOLENOID VALVES "D"			
5/16"	S6N	0.34	0.54
½"	S8F	1.6	2.4
¾"	S4A	4.1	6.4
1"	S4A	5.7	8.9
1¼"	S4A	9.9	16
1½"	S4A	19	30
2"	S4A	28	45
2½"	S4A	40	62
3"	S4A	57	89
INLET REGULATORS "D"			
⅝"*	A7A	1.5	2.2
⅞"	A7A	2.9	4.6
⅞" & 1⅛"	A7A	4.2	6.8
1⅛"	A7A1	8.3	13
1⅜" & 1⅝"	A7A1	9.2	14
1⅝"	A72	15	24
2⅛" & 2⅝"	A72	22	35
SOLENOID VALVES "D"			
5/16"	S6N	0.50	0.79
½"	S8F	2.2	3.5
¾"	S4A	6.0	9.5
1"	S4A	8.3	13
1¼"	S4A	15	23
1½"	S4A	28	44
2"	S4A	41	65
2½"	S4A	58	92
3"	S4A	83	130
[illegible]			

VARIATIONS: Regulator capacities listed apply also to any of the A7 variations "S", "B", "L" and "BL"

RANGES: Regulator Ranges are as follows: D = 75 to 280 psig and A = 10 in. hg. to 90 psig (inlet pressure). The "L" and "BL" variations are available only with Range A

BASIS: Table D capacities are based on the following.
Liquid temperature the same as condensing temperature and 10°F superheat leaving a 0°F evaporator

OTHER EVAPORATOR TEMPERATURES: For capacities at other evaporator temperatures multiply valves listed in Tables, A, B, C or D appropriate factor in Table III.
*⅝" A7A or A7AL with 49% main valve.

R12

R22

R502

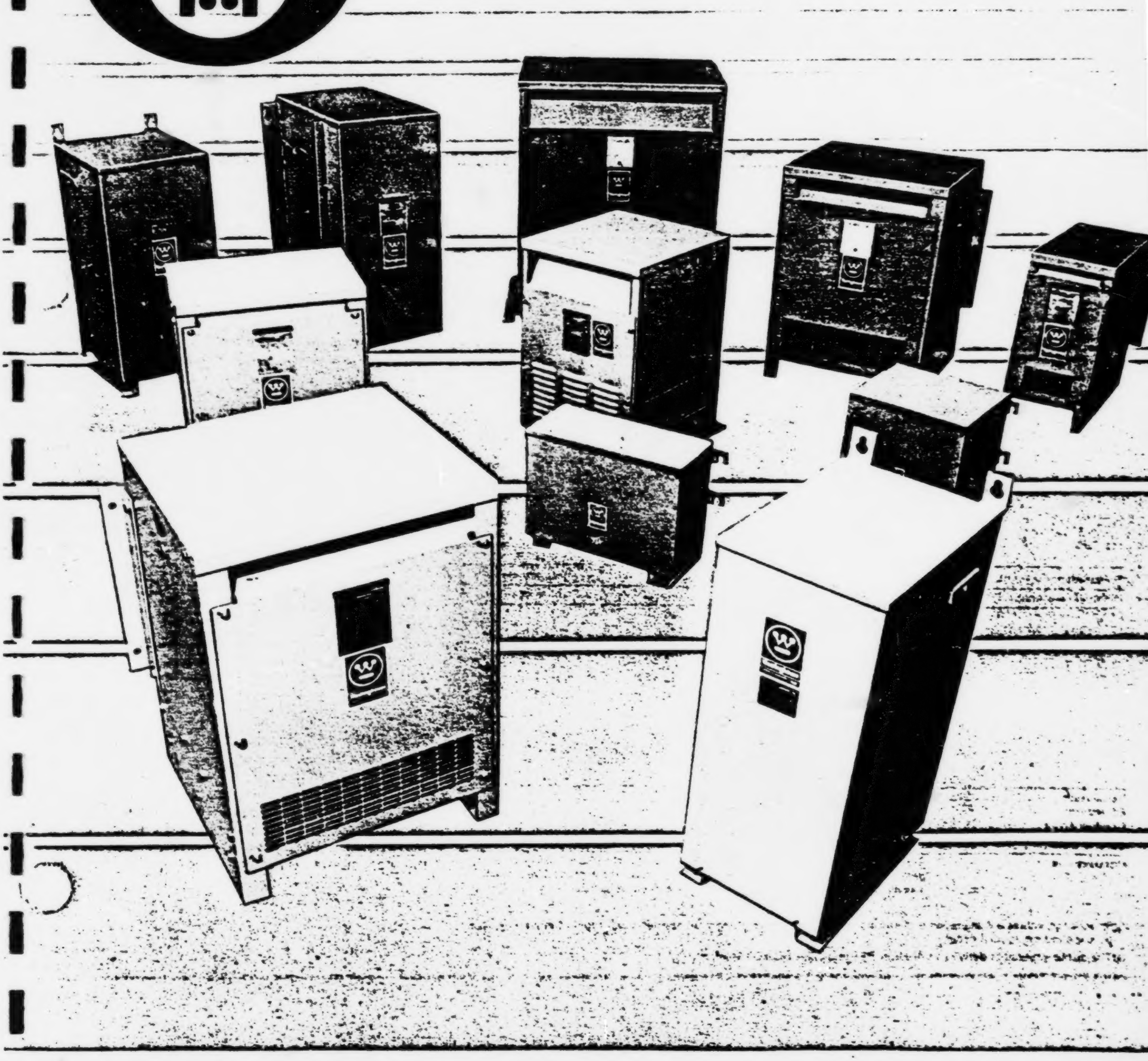
TRANSFORMERS

Distribution, Dry Type

April, 1983

Air Ventilated
600 Volts and Below, 60 Hertz
Type DS and DT

Ecology Transformers



TRANSFORMERS
Distribution, Dry Type

DESCRIPTION

0-666 Kva, Single Phase DS 15-1000 Kva, Three Phase DT General Purpose 600 Volts max., 60 Hertz

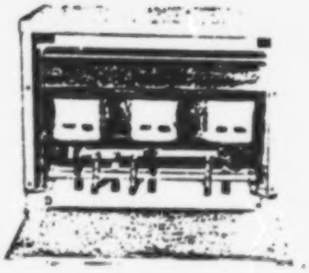
Application

Types DS and DT transformers are ideally suited for indoor application and offer many advantages over liquid-filled transformers. They may be installed in practically any indoor location not subject to submersion or to a high concentration of destructive fumes.

Ecology Transformer

The dry type transformer is a clean, safe, fireproof unit. The dry type protects the nvironment and eliminates hazards making hem ideally suited for installation in places uch as hospitals, schools, hotels where large groups of people are present. Compact size of the dry type is the answer where pace is a problem.

Ecology Transformer



Application Data

	Type DS — Single Phase		Type DT — Three Phase	
Insulation Class	H		H	
Temp. Rise — Coil	150°C		150°C	
Enclosure	30-40°C		30-40°C	
Kv Class	1.2			1.2
Kva Ratings available	10-666 Kva			15-1000 Kva
Standard Taps	4-2½% 2-FCAN 2-FCBN			4-2½% 2-FCAN 2-FCBN
Voltages Available	Primaries	Secondaries	Primaries	Secondaries
	416	120/240	416	208Y/120
	480	347	480	240
	600	416	600	480
		480		600Y/347
		600		600
Basic Impulse Levels (BIL)	Up to 1200 V. Wdg. — 10 Kv.		Up to 1200 V. Wdg. — 10 Kv.	
Mounting Positions	Floor, Wall or Platform		Floor, Wall or Platform	
Sound Levels (Average)	Kva	DB	Kva	DB
	10	45	30	45
	15	45	45	45
	25	45	75	50
	37½	45	112½	50
	50	45	150	50
	75	50	225	55
	100	50	300	55
	150	50	450	60
	200	55	500	60
	250	55	600	62
	333	60	750	64
	500	60	1000	64
	666	62		
% Impedance	Kva··	Primary Voltage	Kva	Primary Voltage
(Approximate only)		Up to 600 Volts		Up to 600 Volts
	10	5.8	30	6.2
	15	6.1	45	6.7
	25	6.0	75	5.7
	37	6.8	112½	7.4
	50	5.8	150	4.6
	75	7.0	225	4.5
	100	4.8	300	5.8
	150	4.7	450	5.4
	200	5.0	500	5.5
	250	6.0	600	6.4
	333	6.4	750	5.5
	500	6.1	1000	6.0
	666	7.0		6.7
Ventilation	Ventilated		Ventilated	
Enclosure	Steel Case		Steel Case	
Conduit Entry	Bottom or Side		Bottom or Side	
ore & Coils	Hipersil Stacked Laminations ①		Hipersil Stacked Laminations ①	
onnections	Bottom Terminal Board c/w Lugs sized per CSA on transformers 200 Kva and less all others bus bars only		Bottom Terminal Board c/w Lugs sized per CSA on transformers 300 Kva and less all others bus bars only	

Impedance values are averages and should be used as guides only. Transformers with higher impedances can be supplied on special order.

①The name Hipersil is derived from High PERmeability SILicon steel.

Design Features

① Case

An in service, removable case is provided with lifting holes to facilitate handling and installation. The case is of knock-down construction on units 300 kVA and less.

② Core

Hipersil① core construction using stacked laminations assures quiet operation throughout transformer life with minimum size and weight.

③ Coils

Coils are insulated with Class H materials to prevent deterioration under heat.

④ End Frame

Rigid end frame provides strength against short circuit stresses to assure dependability.

⑤ Anti-Vibrations Pads

All transformers have their core and coils mounted on Isomode antivibrations pads.

⑥ Terminal Connections

Because of the large choice required to satisfy individual requirements, terminals are not included when primary or secondary line current exceeds 830 amperes. Lugs are installed in the terminal compartment below the core and coil assembly in the bottom of the unit where cooling air is at room ambient temperature with a maximum rise of 5°C. No high temperature or oversized cables are required.

⑦ Wall Mounting

All ratings, 112.5 KVA, 3 phase and below. 75 KVA, 1 phase and below, may be wall mounted with brackets.

⑧

Meet CSA Specifications: Types DS and DT meet all requirements of CSA Standard C9-M1981 for applicable ratings.

⑨

High Overload Capacity and Long Service Life: The Class H silicone insulating system has a high resistance to temporary overload conditions. In addition, the excellent high-temperature, high-humidity endurance of Class H assures long transformer life and reliability, even under the most severe service conditions.

TRANSFORMERS
Distribution, Dry Type

TYPICAL SPECIFICATION

For Single and Three Phase Indoor Ventilated Dry Type Transformers

1. The contractor shall supply and install single phase and/or three phase indoor ventilated dry type transformers in CSA enclosure I wall and/or floor mounted, as indicated on drawings and schedule contained in the specifications.
2. The case shall be provided with:
   a) Removable front and rear plate to permit easy access to taps and to the terminal board.
   b) Highly durable finish of ASA no. 61 light grey.
3. Terminal compartment must be located at bottom of the transformer.
   a) to insure termination of cable leads in ambient temperature levels and eliminate the need for high temperature or over-sized cables.
   b) to provide for side entrance of conduit.
4. Preference will be given to those designs incorporating built-in vibration dampening systems such as used in Westinghouse type DS and DT.
5. Manufacturer will supply lugs as specified on drawings.
6. Transformers to have Class "H" insulation with winding temperature rise not exceeding 150°C and enclosure temperature rise not exceeding 40°C, under full load, in a maximum ambient of 40°C.
7. Transformers cores shall be constructed with high permeability silicon steel (hypersil) using stacked laminations to assure quiet operation and minimize size and weight.
8. Impedance sound level and taps will be in accordance with the published data for Westinghouse type DS and DT unless otherwise specified on drawings.
9. Aluminum nameplate indicating: rating impedance, weight, connection diagram, style and serial numbers, will be riveted on front of transformer case.
10. Transformers are to be built in accordance with CSA standard C9-M1981 or dry type transformers and tested in accordance to section 7 of this publication.
11. All transformers are to be on one make.
12. Transformers shall be Westinghouse.

How to Minimize Sound Amplification in Installation

Sound amplification can be greatly reduced by using the following suggestions in installation:

A. The transformers should be installed in an area where the sound would be the least objectionable.
B. Nearby reflecting objects or enclosures which will resonate, or echo, should be avoided. It is well to avoid mounting the units in areas which tend to amplify voice noises, such as stairways, and hall areas.
C. Tile, brick, concrete, masonry, or steel walls, as well as floors and ceilings, are excellent sounding boards and should be avoided whenever possible. Acoustic absorbing materials may be used too, when they cannot be avoided.
D. Avoid mounting the transformers on walls, partitions, balconies, floors and so forth, having a light mass. If the weight of the mounting surface, corresponding to the projected area of the transformer were greater than or equal to the weight of the transformer, the possibility of amplifying the sound waves in the structure would be greatly reduced.
E. Remove all interior shipping brackets.

Catalogue Number Definition

Type		Primary Voltage		Taps		Secondary Voltage		Phase		kVA		Insulation or Special Features		Design Number
Type	Code	Voltage	Code	Taps	Code	Voltage	Code	Phase	Code	kVA	Code		Code	Code
—floor mtg.	F	120 x 240	10	No Taps	H	24/12	06	Single	S	.25	25	80°C rise	B	1 to 8
—wall mtg.	W	240	24	3–4½% 1—FCAN 2—RCBN	R	120	12	Three	T	.50	51	115°C rise	F	
—floor & wall mtg.	D	240 x 480	20	4–2½% 2—FCAN 2—FCBN	P	120/240	11			.75	76	150°C rise	H	
—totally enclosed non-ventilated DS-E and DT-E only	N	416	40	2–5% FCBN	C	208Y/120	28			1.0	01			
—EP or EPT	S	480	48	2–5% 1—FCAN 1—FCBN	A	240	24			1.5	16			
—Auto-transformer	A	600	60	2–5% 2—RCBN	F	416	40			2.0	02			
				2–5% 1—FCAN 1—RCBN	H	480	48			3.0	03			
						600	60			5.0	05			
						600Y/347	63			7.5	07			
						480Y/277	77			9.0	09			
										10.0	10			
										15.0	15			
										25.0	25			
										30.0	30			
										37.5	37			
										45.0	45			
										50.0	50			
										75.0	75			
										100.0	99			
										112.5	12			
										150.0	49			
										167.0	17			
										200.0	20			
										225.0	22			
										250.0	24			
										300.0	33			
										450.0	46			
										500.0	52			
										600.0	61			
										750.0	74			
										1000.0	96			

Example : Type EP Transformer

W	60	N	12	S	05	B	4
Wall Mtg.	600 Volts Primary	No Taps	120.Volt Secondary	Single Phase	5 kVA	80°C Rise	Design No. 4

TRANSFORMERS
Distribution, Dry Type

Autotransformers — Type DT-A, No Taps, Three Phase, 60 Hz, Class H, 150°C Rise, 30-1000 kVA.

600 Volts Primary, 480 Volts Secondary

Application

Autotransformers often prove economical when the transformation ratio is low. They generally cost less, weigh less and take up less room than their 2 winding counterparts.

kVA	Catalogue Number	Trade Price	Discount Symbol	Wire Range AWG H.V.	Wire Range AWG L.V.
112½▲	A60N48T12H	$1515	N/A	2/0-14	250 MCM-6
150	A60N48T49H	1650	N/A	250 MCM-6	300 MCM-6
225	A60N48T22H	1760	N/A	500 MCM-4	600 MCM-2
300	A60N48T33H	1845	N/A	300 MCM-6	2 (500 MCM-4)
450	A60N48T46H	2360	N/A	3 (600 MCM-2)	4 (600 MCM-2)
500	A60N48T52H	2860	N/A	3 (600 MCM-2)	4 (600 MCM-2)
600	A60N48T61H	3320	N/A	4 (600 MCM-2)	4 (600 MCM-2)
750	A60N48T77H	3600	N/A	4 (600 MCM-2)	4 (600 MCM-2)
1000	A60N48T88H	3740	N/A	4 (600 MCM-2)	4 (600 MCM-2)

Note ▲ For smaller ratings use type EPT-A page 338.

1 Autotransformers are not isolating transformers.

2 Autotransformers are suitable for supplying 3 wire unbalanced loads.

They are suitable for supplying 4 wire unbalanced loads provided that the source is 4 wire providing a neutral return for the unbalanced current.

They are not suitable for use with a 4 wire unbalanced load if the source is only a 3 wire circuit.

Imperial

kVA	Approximate Dimensions Inch			Mtg Holes Dimensions		Net Wt Lbs
①	A	B	C	D	E	
112.5	32.7	23.8	21.5	20.7	16.9	380
150	32.7	23.8	21.5	20.7	16.9	380
225	32.7	23.8	21.5	20.7	16.9	380
300	41.1	26.8	23.7	23.7	19.1	600
450	41.1	26.8	23.7	23.7	19.1	695
500	41.1	26.8	23.7	23.7	19.1	695
600	40.2	33	24.3	35.7	18	1025
750	40.2	33	24.3	35.7	18	1050
1000	40.2	33	24.3	35.7	18	1150

Metric

kVA	Approximate Dimensions mm			Mtg Holes Dimensions		Net Wt Kg
①	A	B	C	D	E	
112.5	829	604	544	526	428	173
150	829	604	544	526	428	173
225	829	604	544	526	428	173
300	1042	679	600	601	484	273
450	1042	679	600	601	484	315
500	1042	679	600	601	484	315
600	1019	838	616	906	457	461
750	1019	838	616	906	457	472
1000	1019	838	616	906	457	518

① A = Height, B = Width, C = Depth see dwg. page 331.

Totally Enclosed (Non-Ventilated), Indoor

Application

These transformers are ideal for industrial applications in atmospheres containing concentrations of dust, lint and moisture. Cooled by natural convection within the enclosure they are non-ventilated to prevent damage by atmospheric contaminants.

Note: Totally Enclosed means only that the enclosure is not ventilated. It does not mean it is "sealed" "dust-tight", "gasketed" or "hermetically sealed" or suitable for installation outdoors.

Prices, 10-225 kVA, 600 Volts and Below, Indoor, Floor Mounting

Primary Volts	Secondary Volts	kVA	Catalogue Number	Trade Price	Discount Symbol	Terminal Wire Range AWG H.V.	Terminal Wire Range AWG L.V.
Type DS-E Single Phase, 600 Volts and Below, 60 Hz, Class H, 150°C Rise							
600①	120/240	10	N60P11S10H	$ 716	N/A	6-14	2-14
1-4½% FCAN		15	N60P11S15H	880	N/A	2-14	2/0-14
2-4½% FCBN		25	N60P11S25H	944	N/A	1/0-14	250 MCM-6
		37.5	N60P11S37H	1462	N/A	2/0-14	500 MCM-4
		50	N60P11S50H	2280	N/A	500 MCM-4	2 (600 MCM-6)
		75	N60P11S75H	2836	N/A	2 (300 MCM-6)	2 (2x600 MCM-2)
		100	N60P11S88H	3306	N/A	2 (600 MCM-2)	2 (2x600 MCM-2)
Type DT-E Three Phase, 600 Volts and Below, 60 Hz, Class H, 150°C Rise							
600①	208Y/120	15	N60P28T15H	$1334	N/A	6-14	1/0-14
		30	N60P28T30H	1613	N/A	2-14	250 MCM-6
		45	N60P28T45H	1968	N/A	2-14	500 MCM-4
2-2½% FCAN		75	N60P28T75H	2263	N/A	2-14	2 (350 MCM-6)
2-2½% FCBN		112½	N60P28T12H	3686	N/A	500 MCM-4	2 (2x600 MCM-2)
		150	N60P28T49H	4832	N/A	2 (300 MCM-6)	2 (2x600 MCM-2)
		225	N60P28T22H	6615		②	②

①Also available with 416 or 480 volts primary at same Trade Price. Order by description.

②Lugs are not included, if required order seperately from modification section, page 333.

Dimensions

See Page 334

TRANSFORMERS
Distribution, Dry Type

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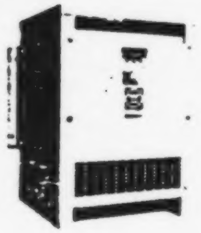
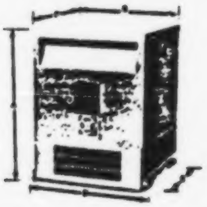
10-666 kVA, Single Phase
General Purpose 600 Volts and Below, 60 Hertz

An Ecology Transformer



Type DS, Single Phase 10-75 kVA
(480 and 600V Primary)

DS



Type DS, Single Phase, 100-200 kVA
(480 and 600V Primary)

Prices, 10-666 kVA, Indoor Ventilated, Floor or Wall Mounting

Primary Volts	Secondary Volts	kVA	Catalogue Number	Trade Price	Discount Symbol	Lugs (wire range AWG)	
						H.V.	L.V.
Type DS Single Phase 600 Volts and Below, 60 Hz, Class H, 150°C Rise							
480 Taps 4-2½% 2-FCAN 2-FCBN	120/240	For ratings below 10 kVA, use Type EP on page 340.					
		* 10	D48P11S10H6	$ 589	P25	6-14	6-14
		* 15	D48P11S15H6	645	P25	6-14	2-14
		* 25	D48P11S25H6	880	P25	2-14	2/0-14
		* 37	D48P11S37H6	944	P25	1/0-14	250 MCM-6
		* 50	D48P11S50H6	1297	P25	2/0-14	500 MCM-4
		* 75	D48P11S75H6	1620	P25	250 MCM-6	2 (350 MCM-6)
		*100	F48P11S99H5	2280	P25	500 MCM-4	2 (600 MCM-6)
		*150	F48P11S49H5	2835	P25	2 (300 MCM-6)	2 (2 x 600 MCM-2)
		*200	F48P11S20H5	3308	P25	2 (600 MCM-2)	2 (2 x 600 MCM-2)
		250	F48P11S24H5	3920	P25	**	**
		300	F48P11S33H5	6520	P25	**	**
		333	F48P11S34H5	6665	P25	**	**
		500	F48P11S52H5	7640	P25	**	**
		666	F48P11S66H5	8465	P25	**	**
600 Taps 4-2½% 2-FCAN 2-FCBN	120/240	For ratings below 10 kVA, use Type EP on page 340.					
		* 10	D60P11S10H6	589	P25	6-14	6-14
	--	* 15	D60P11S15H6	645	P25	6-14	2-14
		* 25	D60P11S25H6	880	P25	2-14	2/0-14
		* 37	D60P11S37H6	944	P25	2-14	250 MCM-6
		* 50	D60P11S50H6	1297	P25	1/0-14	500 MCM-4
		* 75	D60P11S75H6	1620	P25	250 MCM-6	2 (350 MCM-6)
		*100	F60P11S99H5	2280	P25	300 MCM-6	2 (600 MCM-2)
		*150	F60P11S49H5	2835	P25	600 MCM-2	2 (2 x 600 MCM-2)
		*200	F60P11S20H5	3308	P25	2 (500 MCM-4)	2 (2 x 600 MCM-2)
		250	F60P11S24H5	3920	P25	**	**
		300	F60P11S33H5	6520	P25	**	**
		333	F60P11S34H5	6665	P25	**	**
		500	F60P11S52H5	7640	P25	**	**
		666	F60P11S66H5	8465	P25	**	**
		For ratings above 200 Kva refer to Westinghouse					

Notes

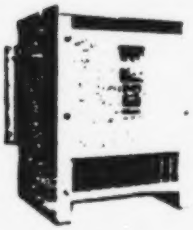
For Dimensions refer to page 334
10 kVA to 75 kVA can be wall and floor mounted. The mounting feet are simply re-located to be used for wall mounting.
*NSPL items. - normally stocked.
**Lugs are not included; if required order seperately from modification section page 333

TRANSFORMERS

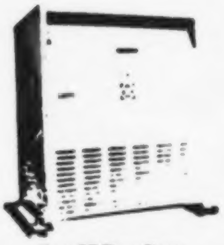
Distribution, Dry Type

TRADE PRICES

30-1000 kVA, Three Phase
General Purpose
600 Volts and Below, 60 Hertz



Type DT Three Phase
30-112.5 kVA (up to 600V)



Type DT Three Phase
150-225 kVA (up to 600V)

DT

An
Ecology
Transformer

Prices, 30-750 kVA, Indoor Ventilated, Floor or Wall Mounting

Primary Volts	Secondary Volts	kVA	Catalogue Number	Trade Price	Discount Symbol	Lugs (wire range AWG)	
						H.V.	L.V.
Type DT Three Phase, 600 Volts and Below, 60 Hz, Class H, 150°C Rise							
		For ratings below 30 kVA, use EPT, page 342					
480 (2-2½% FCAN and 2-2½% FCBN Taps)	208Y/120	• 30	D48P28T30H6	$ 1060	P25	6-14	1/0-14
		• 45	D48P28T45H6	1205	P25	2-14	250 MCM-6
		• 75	D48P28T75H6	1630	P25	1/0-14	500 MCM-4
		•112½	D48P28T12H6	2263	P25	250 MCM-6	2 (350 MCM-6)
		•150	F48P28T49H5	3183	P25	300 MCM-6	2 (600 MCM-2)
		•225	F48P28T22H5	3586	P25	600 MCM-2	2 (2 x 600 MCM-2)
		•300	F48P28T33H5	4832	P25	2 (500 MCM-4)	2 (2 x 600 MCM-2)
		•450	F48P28T46H5	8615	P25	①	①
		•500	F48P28T52H5	8910	P25	①	①
		•600	F48P28T61H5	9680	P25	①	①
		•750	F48P28T74H5	10558	P25	①	①
		•1000	F48P28T98H5	11950	P25	①	①
		For ratings below 30 kVA, use Type EPT, page 342					
600 (2-2½% FCAN and 2-2½% FCBN Taps)	208Y/120	• 30	D60P28T30H6	$ 1060	P25	6-14	1/0-14
		• 45	D60P28T45H6	1205	P25	2-14	250 MCM-6
		• 75	D60P28T75H6	1630	P25	2-14	500 MCM-4
		•112½	D60P28T12H6	2263	P25	2/0-14	2 (350 MCM-6)
		•150	F60P28T49H5	3183	P25	250 MCM-6	2 (600 MCM-2)
		•225	F60P28P22H5	3586	P25	500 MCM-4	2 (2 x 600 MCM-2)
		•300	F60P28T33H5	4832	P25	2 (300 MCM-6)	2 (2 x 600 MCM-2)
		•450	F60P28T46H5	8615	P25	①	①
		•500	F60P28T52H5	8910	P25	①	①
		•600	F60P28T61H5	9680	P25	①	①
		•750	F60P28T74H5	10558	P25	①	①
		•1000	F60P28T98H5	11950	P25	①	①

Notes
For Dimensions refer to page 334.
SPL items — normally stocked
· kVA to 112.5 kVA can be wall and floor mounted.
Lugs are not included, if required order separately from modification section page 333.

TRANSFORMERS
Distribution, Dry Type

April, 1983

MODIFICATIONS

10-666 kVA, Single Phase DS; 30-1000 kVA, Three Phase DT
General Purpose 600 Volts and Below, 60 Hertz

Price Modification Section

Discount symbol P25 will apply.

General Notes
Regardless of the apparent simplicity of most deviations from standard design transformers, each special rating generally requires additional expense in design engineering and manufacturing. As such, standard ratings wherever possible, should be used as an alternate to a special rating. The advantages of standards, include lower price, short time (usually stock) availability, and easy future replacement.

A. Percent Additions To Unit Price

1. Special Voltage Ratings
For voltages other than shown on pages 331 & 332, add 30%

2. Special Frequency
50 Hertz, add 12½%
(minimum charge $200.)

3. Special Taps
Refer to Westinghouse

4. Special 45dB Sound Levels
Where 45dB guaranteed sound level values are required, add 15%
For ratings above 300 kVA, refer to Westinghouse.

5. Special Impedance
Refer to Westinghouse

6. Electrostatic Shielding
For electrostatic shields between HV & LV windings, add 15%

B. Dollar Additions to Unit Price

1. Overseas Packing
Up to 225 kVA, add .... $150.
226 to 600 kVA, add .... $225.
above 600 kVA, add .... $300.

2. Fungus Proofing
For fungus proofing, add .... $150.

3. Provision For Bus Duct Entry

Bussed in at Factory			
Bus Duct Amps	Aluminum Bus Duct	Copper Bus Duct	Flexible Kit For Field Assembly
225	780 1075	150	
600	820 1360	175	
1600	980 1695	350	
2000	1045 2035	475	

Available on 300 kVA and above

Note: For other than "Westinghouse" bus duct refer to Westinghouse.

4. Special Paint Finish
For any color other than ASA #61 Light Grey Base order for one unit .... $130.
Each additional unit .... $65.

Note
The special paint must be compatible with ASA #61 and air dryed. If not, refer to Westinghouse.

5. Lightning Arresters
For 3 type MV lightning arresters, add .... $330.

6. Temperature Indicators
For dial type winding temperature indicator with alarm contacts, add .... $700.

7. Dripproof Enclosure
up to 45 kVA, add .... $130.
46 to 150 kVA, add .... $195.
151 to 300 kVA, add .... $260.
301 to 600 kVA, add .... $325.
Above 600 kVA, add .... $650.

8. Anti-Vibrations Pads
a) For additional isomode pads, add .... $45.
b) For Korfund, add .... $95.

9. Temperature Rise
For 80°C rise rise using class H materials only, use price of kVA rating next size up.

10. Special Application Transformers
For Marine transformers per IEEE-45, refer to Westinghouse.

11. List Prices for Lugs Assemblies

Cat. No.*	Approved Wire Range	Fig. No.	List Price
Single Lugs			
E7070	250 MCM — #6	1	$28.00
E7075	350 MCM — #6	1	31.00
E7080	500 MCM — #4	1	34.00
E7085	600 MCM — #2	1	40.00
Double Lugs			
E7095	350 MCM — #6	2	56.00
E7100	600 MCM — #2	3	60.00
Triple Lugs			
E7105	350 MCM — #6	4	158.00
E7110	500 MCM — #2	4	198.00
E7115	800 MCM — 350 MCM	4	277.00

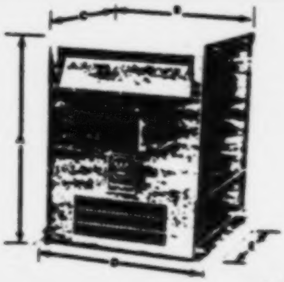
*Each cat. no. consist of 4 lugs with hardware.

12. Special Tests Requirements
a) Temperature test ** add .... $1100.
b) Sound level ** add .... $450.
c) Certified test results of standard production tests, add .... $130.

**Price includes certified test results. For witness tests just prior to shipment, increase price of test by 50% to cover test duplication.

TRANSFORMERS
Distribution, Dry Type

DIMENSIONS



Imperial Approximate Dimensions Inches A	B	C	Mtg. Holes Dimensions D	E	Net Wt. Lbs.	kVA	Metric Approximate Dimensions mm A	B	C	Mtg. Holes Dimensions D	E	Net Wt. kg.
Indoor Ventilated, Type DS Single Phase												
24.8	12.1	21.1	9.1	16.9	155	10	630	306	543	230	428	71
24.8	12.1	21.4	9.1	16.9	177	15	630	306	543	230	428	80
30.9	15.2	23.7	12.2	19.1	275	25	784	386	600	308	484	125
30.9	15.2	23.7	12.2	19.1	305	37	784	386	600	308	484	138
41.1	18.3	23.7	15.3	19.1	445	50	1042	464	600	388	484	202
41.1	18.3	23.7	15.3	19.1	500	75	1042	464	600	388	484	227
40.1	23.8	24.3	25.4	18	690	100	1019	605	616	644	457	313
40.1	23.8	24.3	25.4	18	790	150	1019	605	616	644	457	358
57.3	26.5	28.3	29.8	21	1100	200	1456	673	717	757	534	500
57.3	26.5	32.5	29.8	21	1360	250	1456	673	826	757	534	617
72.3	35.9	42.3	31.8	24	2560	333	1837	912	1075	808	610	1161
72.3	35.9	42.3	31.8	24	3100	500	1837	912	1075	808	610	1406
78.3	35.9	42.3	31.8	24	3525	666	1989	912	1075	808	610	1599
Type DT Three Phase												
32.7	23.8	21.5	20.7	16.9	380	30	829	604	544	526	428	173
32.7	23.8	21.5	20.7	16.9	435	45	829	604	544	526	428	197
41.1	26.8	23.7	23.7	19.1	600	75	1042	679	600	601	484	273
41.1	26.8	23.7	23.7	19.1	695	112½	1042	679	600	601	484	315
40.2	33.1	24.3	35.4	18	1050	150	1019	840	616	898	457	476
40.2	33.1	24.3	35.4	18	1160	225	1019	840	616	898	457	526
57.3	38.3	28.3	41.5	21	1670	300	1454	971	717	1054	533	757
72.3	52.3	42.3	48.2	24	3500	450	1835	1329	1073	1222	610	1587
72.3	52.3	42.3	48.2	24	3600	500	1835	1329	1073	1222	610	1633
72.3	52.3	42.3	48.2	24	3750	600	1835	1329	1073	1222	610	1700
72.3	52.3	42.3	48.2	24	4075	750	1835	1329	1073	1222	610	1848
78.3	52.3	42.3	48.2	24	5200	1000	1987	1329	1073	1222	610	2358
Totally Enclosed (Non-Ventilated) Type DS-E Single Phase												
24.8	12.1	21.4	9.1	16.9	177	10	630	306	543	230	428	80
30.9	15.2	23.7	12.2	19.1	275	15	784	386	600	308	484	125
30.9	15.2	23.7	12.2	19.1	305	25	784	386	600	308	484	138
41.1	18.3	23.7	15.3	19.1	445	37	1042	464	600	388	484	202
40.1	23.8	24.3	25.4	18	690	50	1019	605	616	644	457	313
40.1	23.8	24.3	25.4	18	790	75	1019	605	616	644	457	358
57.3	26.5	28.3	29.8	21	1100	100	1454	673	717	755	533	500
Totally Enclosed (Non-Ventilated) Type DT-E Three Phase												
32.7	23.8	21.5	20.7	16.9	380	15	829	604	544	526	428	173
32.7	23.8	21.5	20.7	16.9	435	30	829	604	544	526	428	197
41.1	26.8	23.7	23.7	19.1	600	45	1042	679	600	601	484	273
41.1	26.8	23.7	23.7	19.1	695	75	1042	679	600	601	484	315
40.2	33.1	24.3	35.4	18	1160	112½	1019	840	616	898	457	526
57.3	38.3	28.3	41.5	21	1670	150	1454	971	717	1054	533	757
72.3	52.3	42.3	48.2	24	3600	225	1835	1329	1073	1222	610	1633

Prices include Federal sales tax at 5% and are subject to change without notice.

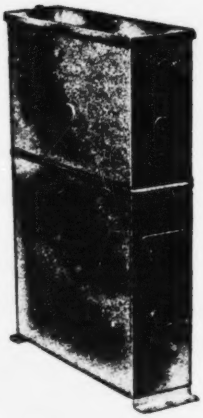
Westinghouse Canada Inc.
Distribution Apparatus

Catalogue Section
55-630 (E)

February, 1982
Supersedes issue dated November, 1977

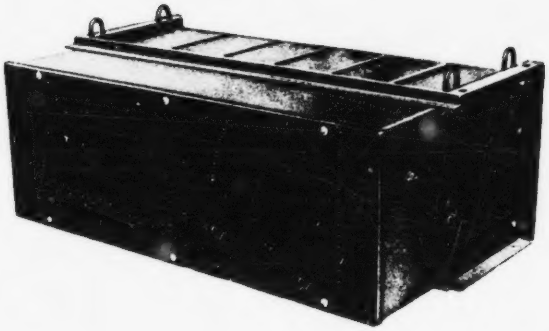
240, 480, 600, 2400 and 4160 Volts
1 and 3 Phase, 60 Hertz
Indoor and Outdoor .75 to 300 kVAc

Industrial Capacitors Types IDP, HDP Multiple Type MDP



Type IDP

Type HDP
Two Unit



Single Tier, Type MDP

Westinghouse dustproof and weatherproof capacitor designs meet all CSA requirements for power factor improvement in the average industrial plant.

Type IDP:

Individual indoor low voltage dustproof units provide small amounts of corrective capacity near the load, when connected directly on machine terminals or at load centers. The units may be located on the load side of the circuit and may be switched "on" or "off" with the load. By switching through the motor or load center controls, separate switches are not required. Such applications also provide semi-automatic control of corrective capacity to avoid over-voltage conditions during light load periods.

Type HDP:

Indoor and outdoor high voltage capacitor assemblies with type DV DYNA-VAC low loss film capacitor units are designed for use on primary circuits where limited amounts of kVAc are required. They can be installed directly at the motor terminal or at load centers to improve power factor. When applied on the load side of a motor starter, a separate switch is not required resulting in a low installed cost per kVAc. Each 3 phase unit is individually fused with 3 current limiting fuses and is supplied with floor mounting brackets.

Type MDP:

Multiple indoor low voltage dustproof units provide for larger amounts of capacity needed at power centers than could be economically obtained through large groups of individual dustproof Type IDP units or through other types of installations.

Advantages

Protection:

The dustproof and weatherproof designs protect against entrance of foreign matter and also isolate live parts from accidental contact. Approved by CSA.

Accessibility:

Terminals, indicating type fuses and connections are readily accessible upon removal of the terminal enclosure cover.

Flexibility:

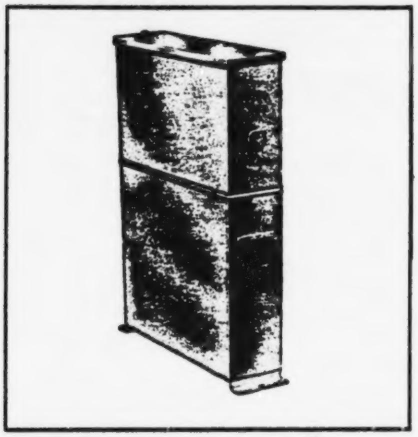
One or more Type IDP or HDP units may be floor or platform mounted, or suspended on mounting brackets from wall or ceiling.

The multiple Type MDP unit consists of groups of capacitors completely assembled and wired to form a single unit having terminals and connections enclosed in a dustproof compartment. The units are designed for stacking on each other, up to three tiers high.

The capacity of either single or multiple units may be increased or decreased by adding or subtracting units, or by substituting units of other ratings as required. When the number of units supplied is less than the total capacity of the rack, dustproof covers are furnished for the vacant openings.

Low Voltage — Indoor Type IDP

Selector Guide



① Single phase units can be supplied — refer to Ⓦ

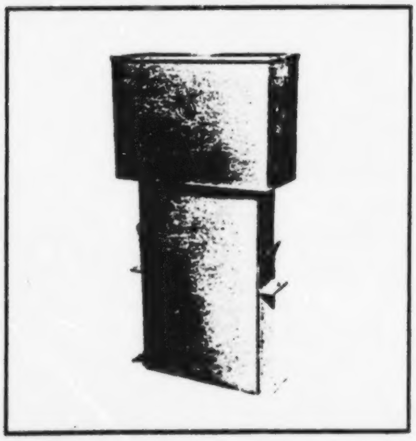
③ For shipping weight, add 2.3 kg.

⑤ Has side wall mounting brackets.

Volts	kVAc	3 Phase Style Number①	Fluid Content WEMCOL Litres	Approx. Net Weight Kg③	Dimensions in mm (Ref. Fig. A. p. 3)
240	.75	1950B24A01	2.18	9.1	330.2
	1.25	1950B24A02	2.95	9.6	349.3
	1.62	1950B24A03	2.68	10.9	365.3
	2.5	1950B24A04	2.95	12.7	400.1
	3.25	1950B24A05	3.36	14.6	434.8
	4.0	1950B24A06	3.64	16.4	460.3
	5.0	1950B24A07	3.64	18.2	501.7
	5.5⑤	1950B24A08	4.36	19.5	527.05
	6.25⑤	1950B24A09	4.73	20.9	552.5
	7.5⑤	1950B24A10	5.00	23.6	606.6
	8⑤	1950B24A11	5.34	25.0	625.4
	8.75⑤	1950B24A12	5.73	26.4	657.4
	10⑤	1950B24A13	6.14	29.1	708.2
	11.25⑤	1950B24A14	6.13	31.8	755.7
	12.5⑤	1950B24A15	7.27	35.5	815.9
	15⑤	1950B24A16	8.18	40.0	895.4
480	3	1950B48A01	2.18	9.1	330.2
	5	1950B48A02	2.95	9.6	349.3
	6.5	1950B48A03	2.68	10.9	365.3
	10	1950B48A04	2.95	12.7	400.1
	12.5	1950B48A05	3.36	14.6	434.8
	15	1950B48A06	3.64	16.4	460.3
	20	1950B48A07	3.64	18.2	501.7
	22.5⑤	1950B48A08	4.38	19.5	527.1
	25⑤	1950B48A09	4.73	20.9	552.5
	30⑤	1950B48A10	5.00	23.6	606.6
	32.5⑤	1950B48A11	5.34	25.0	625.4
	35⑤	1950B48A12	5.73	26.4	657.4
	40⑤	1950B48A13	6.14	29.5	708.2
	45⑤	1950B48A14	6.73	32.3	755.7
	50⑤	1950B48A15	7.27	35.9	815.9
	60⑤	1950B48A16	8.18	40.5	895.4
600	5	1950B60A01	2.18	9.1	330.2
	7.5	1950B60A02	2.93	9.6	349.3
	10	1950B60A03	2.68	10.9	365.3
	15	1950B60A04	2.95	12.7	400.1
	20	1950B60A05	3.36	14.6	434.8
	25	1950B60A06	3.64	16.4	460.3
	30	1950B60A07	3.64	18.2	501.7
	35⑤	1950B60A08	4.36	19.5	527.1
	40⑤	1950B60A09	4.73	20.9	552.5
	45⑤	1950B60A10	5.0	23.6	606.6
	50⑤	1950B60A11	5.34	25.5	625.4
	55⑤	1950B60A12	5.73	26.8	657.4
	60⑤	1950B60A13	6.14	30.0	708.2

High Voltage — Indoor Type HDP*

Selector Guide



① Single phase units can be supplied — refer to Westinghouse.

③ For shipping weight, add 4.6 kg.

Volts	kVAc	3 Phase① Style Number	Fluid Content WEMCOL Litres	Approx. Net Weight Kg③	Dimensions in mm (Ref. Fig. B — see page 3)			
					A	B	C	D
Single Unit Assemblies								
2400	50	1875C01A01	2.68	31	215	710	120	22
	75	1875C01A02	3.77	35	295	790	120	102
	100	1875C01A03	4.77	39	365	860	120	165.1
	125	1875C01A04	7.95	50	515	1010	120	318
	150	1875C01A05	7.95	50	515	1010	120	318
4160	50	1875C01A15	2.68	31	215	710	120	22
	75	1875C01A16	3.97	35	295	790	120	102
	100	1875C01A17	4.77	39	365	860	120	165.1
	125	1875C01A18	7.95	50	515	1010	120	318
	150	1875C01A19	7.95	50	515	1010	120	318
Two Unit Assemblies								
2400	175	1875C02A01	0.00	67	365	860	120	165.1
	200	1875C02A02	0.00	71	365	860	120	165.1
	225	1875C02A03	0.00	82	515	1010	120	318
	250	1875C02A04	0.00	92	515	1010	120	318
	275	1875C02A05	0.00	92	515	1010	120	318
	300	1875C02A06	0.00	92	515	1010	120	318
4160	175	1875C02A11	0.00	68	365	860	120	165.1
	200	1875C02A12	0.00	72	365	850	120	165.1
	225	1875C02A13	0.00	82	515	1010	120	318
	250	1875C02A14	0.00	92	515	1010	120	318
	275	1875C02A15	0.00	92	515	1010	120	318
	300	1875C02A16	0.00	92	515	1010	120	318

***Outdoor HDP Units**
Weatherproof outdoor HDP units can be furnished in any of the ratings shown above.

May, 1982
Supersedes 55-630 (E)
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Industrial Capacitors Multiple Type IDP, HDP

Dimensions, in mm (approximate)

Figure A — Indoor Type IDP

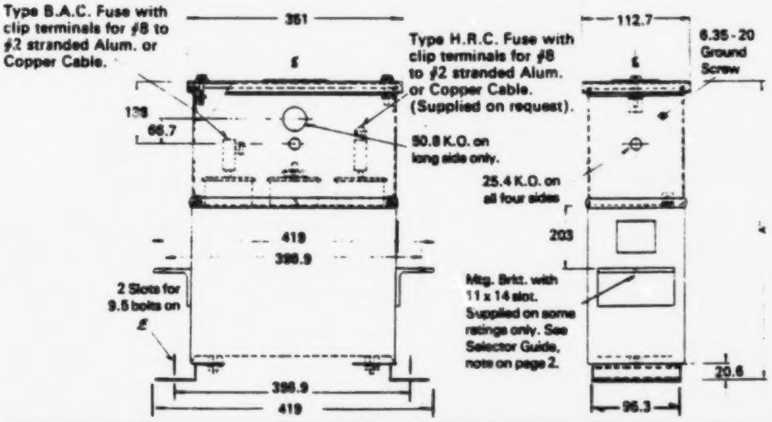
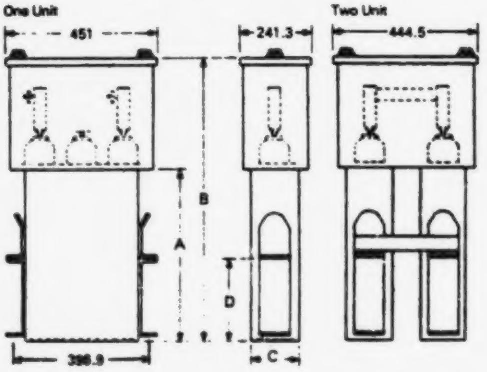

Type B.A.C. Fuse with clip terminals for #8 to #2 stranded Alum. or Copper Cable.
381
112.7
6.35 - 20 Ground Screw
Type H.R.C. Fuse with clip terminals for #8 to #2 stranded Alum. or Copper Cable. (Supplied on request).
139
66.7
50.8 K.O. on long side only.
25.4 K.O. on all four sides
419
396.9
203
2 Slots for 9.5 bolts on ℄
Mtg. Brkt. with 11 x 14 slot. Supplied on some ratings only. See Selector Guide, note on page 2.
20.6
396.9
419
96.3

Figure B — Indoor Type HDP*


One Unit
451
241.3
Two Unit
444.5
B
A
D
C
396.9

Brackets — Low Voltage Type IDP (See Figures C, D and E)

Bracket Capacity, Units	Style Number	Dimension Reference			
		Fig.	D	E	F
For Wall Mounting					
1, 2	3456A21G01	C	...	...	...
3	3456A21G03	D	394	...	...
4	3456A21G04	D	305	...	...
For Ceiling Mounting					
1	402A508H14	E	76.2	76.2	76.2
2	402A508G04	E	406	451	22.2
3	402A508G05	E	584	629	22.2
4	402A508G06	E	406	762	178

Figure C

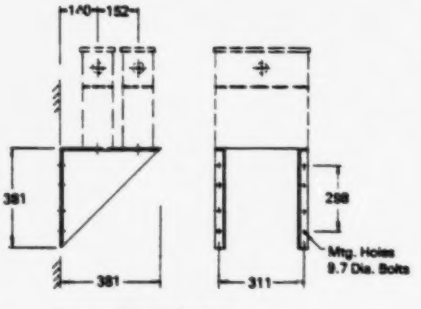

140
152
381
298
381
311
Mtg. Holes 9.7 Dia. Bolts

Figure D

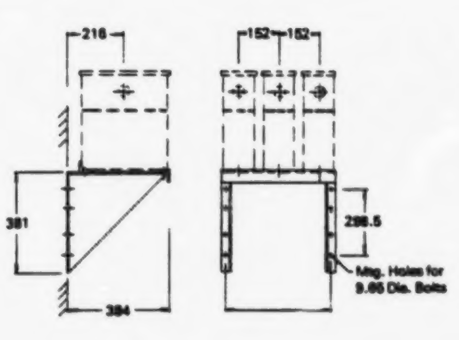
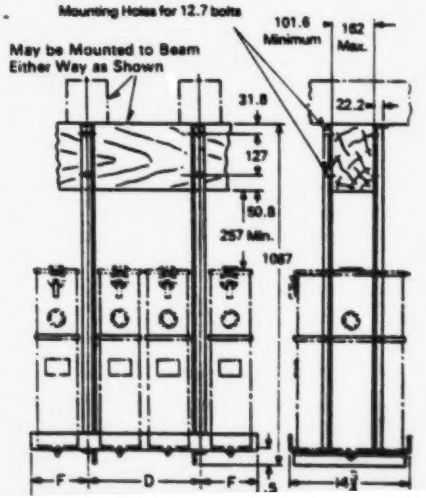
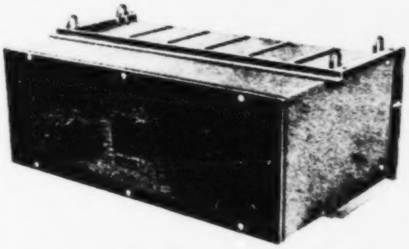

216
152
152
381
298.5
Mtg. Holes for 9.65 Dia. Bolts
394

Figure E


Mounting Holes for 12.7 bolts
101.6 Minimum
162 Max.
May be Mounted to Beam Either Way as Shown
31.8
22.2
127
50.8
257 Min.
1067
F
D
F
E

Multiple Type MDP

Multiple Type MDP — 240, 480 and 600 Volts, 30 to 1200 kVAc, 1 and 3 phase, 60 Hertz, Indoor



Single Tier, Type MDP

Selector Guide

Single Tier Equipment

Voltage	kVAc ①	Quantity and Size of Capacitor Units②	3 Phase Style Number	Dimension Refer to Page 5		Apprx. Net. Wt. Kg.	Line Connectors
				Fig.	Item		
240	30	2-15	218D824A01	G	1	114	#1 to #4/0
	45	3-15	218D824A04	G	2	157	#1 to #4/0
	60	4-15	218D824A07	G	3	198	250 to 500 MCM
	75	5-15	218D824A10	G	4	239	250 to 500 MCM
480	75	1-35, 1-40	218D848A02	G	1	89	#1 to #4/0
	100	2-50	218D848A07	G	1	104	#1 to #4/0
	125	2-40, 1-45	218D848A12	G	2	127	#1 to #4/0
	150	3-50	218D848A17	G	2	143	250 to 500 MCM
	175	1-40, 3-45	218D848A22	G	3	164	250 to 500 MCM
	200	4-50	218D848A27	G	3	179	250 to 500 MCM
	225	5-45	218D848A32	G	4	198	250 to 500 MCM
600	80	2-40	218D860A01	G	1	75	#1 to #4/0
	100	2-50	218D860A05	G	1	82	#1 to #4/0
	125	1-45, 2-40	218D860A10	G	2	102	#1 to #4/0
	150	3-50	218D860A15	G	2	111	#1 to #4/0
	175	1-55, 2-60	218D860A20	G	2	120	250 to 500 MCM
	200	4-50	218D860A25	G	3	139	250 to 500 MCM
	225	3-55, 1-60	218D860A30	G	3	145	250 to 500 MCM
	250	5-50	218D860A35	G	4	164	250 to 500 MCM
	275	5-55	218D860A40	G	4	170	250 to 500 MCM
	300	5-60	218D860A45	G	4	184	250 to 500 MCM

①**Intermediate Ratings**:

The "kVAc" ratings listed in the "Selector Guide" are based on using the quantity and kVAc rating of capacitor units as indicated in column 3. Intermediate ratings may be obtained by omitting units, or by substituting units of smaller kVAc ratings. When the number of individual units supplied is less than the total capacity of the tier, dust-proof steel covers are furnished for the vacant openings. Intermediate ratings are available in steps of 5 kVAc.

②**Capacitor Units and Fuses**:

The type MDP Capacitor Equipment is an assembly consisting of individually fused, three phase type DV capacitor units with the terminals and fuses enclosed in a dust-proof enclosure.

All capacitors are fused with HRC fuses having 100,000 amperes interrupting capacity.

Multiple Tier Equipment

Ratings — Single banks up to 225 kVAc at 240 volts and 600 kVAc at 480 and 600 volts may be obtained by bolting together single tiers of the same unit capacity (listed above), to a maximum of three tiers high.

Interconnections — Equipment is shipped in single tiers for assembly by the Purchaser unless otherwise specified. Interconnected tiers can be supplied if specified except when 2 tier equipment exceeds 100 kVAc at 240 volts, 210 kVAc at 480 volts and 250 kVAc at 600 volts or when 3 tier equipment exceeds 80 kVAc at 240 volts, 160 kVAc at 480 volts and 200 kVAc at 600 volts. In these cases each tier must be entered separately and connections paralleled at a switch or factory installed bus gutter. Three tiers can be installed on either side of the gutter. Refer to Westinghouse.

May, 1982
Supersedes 55-630 (E)
Page 5, dated November, 1977

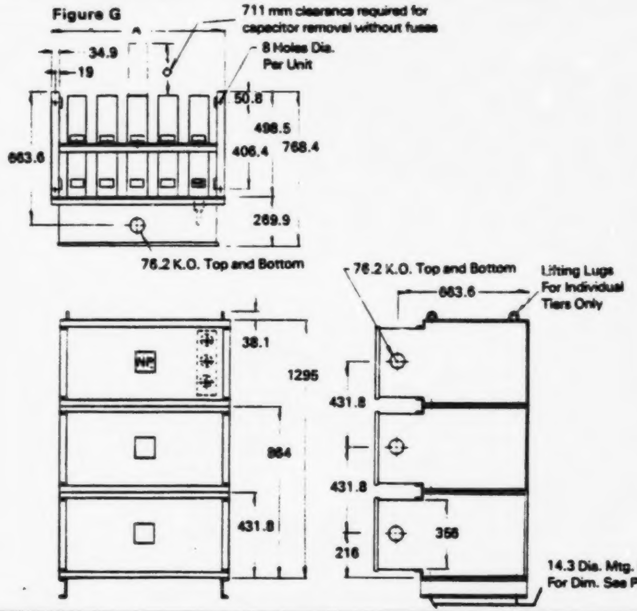
Industrial Capacitors Multiple Type MDP

Dimensions, in mm (approximate)
Indoor Type MDF

DIMENSIONS A

Ref. Item	Fig. G
1	400
2	552
3	705
4	857

Figure G


711 mm clearance required for capacitor removal without fuses
A
34.9
19
8 Holes Dia. Per Unit
50.8
498.5
406.4
768.4
663.6
269.9
76.2 K.O. Top and Bottom
76.2 K.O. Top and Bottom
663.6
Lifting Lugs For Individual Tiers Only
NP
38.1
1295
431.8
864
431.8
431.8
356
216
14.3 Dia. Mtg. Holes For Dim. See Plan View

Installation

Temperature Limits

Dustproof equipments are dependent on natural air circulation for cooling. Location in a dead air space should be avoided and restrictive enclosures or covers which will reduce the natural flow of air between the units should not be used. Radiation from nearby hot surfaces may prevent efficient cooling.

Maximum ambient temperature limits are as follows:

Type	Number of Tiers	Maximum Ambient Temperature (Degrees)
IDP, HDP, MDP	1	46C (115F)
MDP	2-3	40C (140F)

Selection of Switches and Breakers

When an equipment is installed with less than the full number of units, the switch or circuit breaker used should be that listed for the full kVAc of the equipment. Breakers and switches for use with capacitors must have a current rating in excess of rated capacitor current to provide for overcurrent due to overvoltage at fundamental frequency and harmonic currents. The following percent of the capacitor rated current should be used:

Fused and unfused safety switches	165 percent
Type AB-I De-ion breakers or equivalent	150 percent
Air circuit breakers, type DS	135 percent
Oil circuit breakers, all types	135 percent
Contactors	
Open type	135 percent
Enclosed type	150 percent

Floor Mounting: Single or multiple tier assemblies should be placed in a suitable location and bolted to the floor with the terminal compartment toward the front. Clearance should be allowed at the rear of the assembly to permit removal of the individual capacitor units.

Note: Do not mount the tiers on end, restricting ventilation.

Wall Mounting: Fig. H shows the wall mounting arrangement for single tier equipments only. Single tiers may be bolted directly to the wall with the terminal compartment up. Clearance should be allowed at the bottom of the equipments to permit removal of the individual capacitor units.

Ceiling Mounting: Fig. I shows the ceiling mounting arrangement for single tier equipments only. The assembly is suspended from the ceiling by screws, rods, or bolts through the top flange on the ends of the rack. (Suspension rods or straps are to be supplied by the purchaser.)

Multi-tier ceiling mounting is not recommended.

Figure H — Wall Mounting, Single Tier

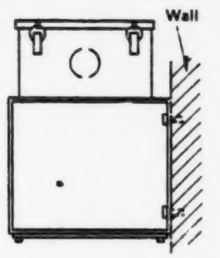
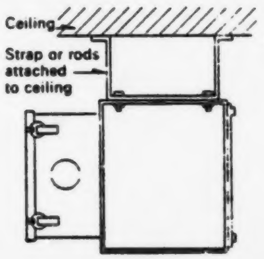
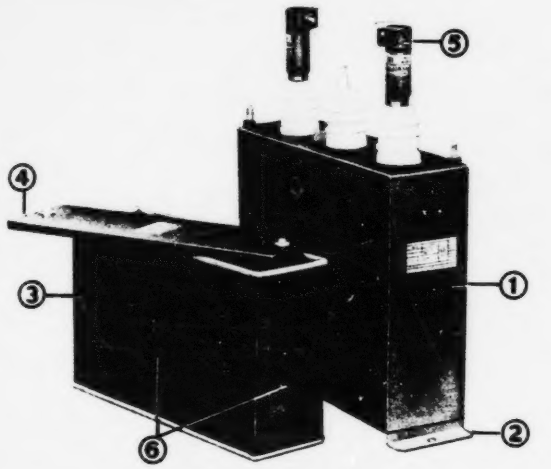


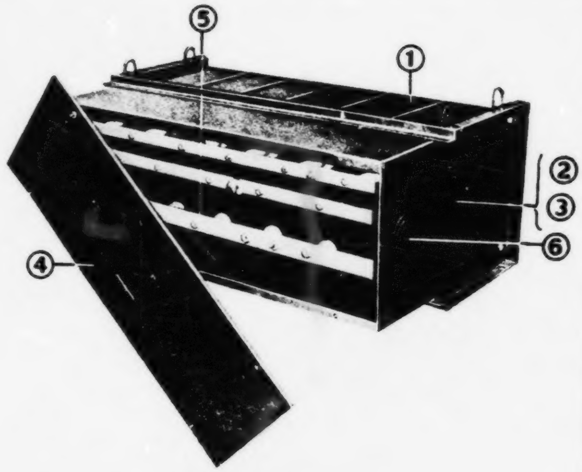
Figure I — Ceiling Mounting, Single Tier


Ceiling
Strap or rods attached to ceiling

Design Features — Type IDP and MDP



Type IDP — Low Voltage



Type MDP — Single Tier

① Individual Capacitor, Type DV

The basic unit of individual and multiple dustproof equipment is the same as the indoor units described in detail in Catalogue Section 55-620 page 1. These type DV indoor capacitor units incorporate all the features of gland-sealed bushings, Wamcol dielectric, internal discharge resistors, sturdy case construction equipment, the units are mounted on edge with the terminals projecting through a sheet steel panel of the welded frame assembly.

② Frame and Mounting Arrangements

Type IDP — provision for floor mounting only. Brackets are required for ceiling or wall mounting, in which case the mounting feet are discarded.

Type MDP — a heavy jig-fabricated terminal enclosure and frame assures proper alignment, supports the capacitor units and provides spacing to ensure proper ventilation.

Single banks up to 600 kVAc maximum may be obtained by bolting together combinations of single tiers which must have the same unit capacity. Three tiers is the maximum which may be combined into a single equipment for floor mounting. Two or three tiers are not recommended for ceiling mounting. (See more detail under "installation," page 5).

③ Enclosure

Type IDP — a formed, heavy sheet steel enclosure, with neoprene gaskets at the top and bottom, is bolted to the top of the capacitor unit by means of weld nuts and studs, enclosing the terminals, fuses and connections.

Type MDP — a uni-constructed welded frame encloses the terminals, fuses and connections of the capacitor units.

④ Enclosure Cover

Type IDP — a steel cover compresses the top neoprene gasket to complete the dustproof seal, making the entire unit impervious to foreign matters such as dust and lint. The cover may be easily removed for inspecting fuses and connections.

Type MDP — a formed, sheet steel cover is fastened to the terminal enclosure and may be easily removed for inspecting fuses and connections.

Two sets of felt gaskets are provided to complete the dustproof seal. These are located (1) between each capacitor unit and the frame side panel; (2) between the front of the terminal enclosure and the enclosure cover.

⑤ Individual Fuses and Connectors

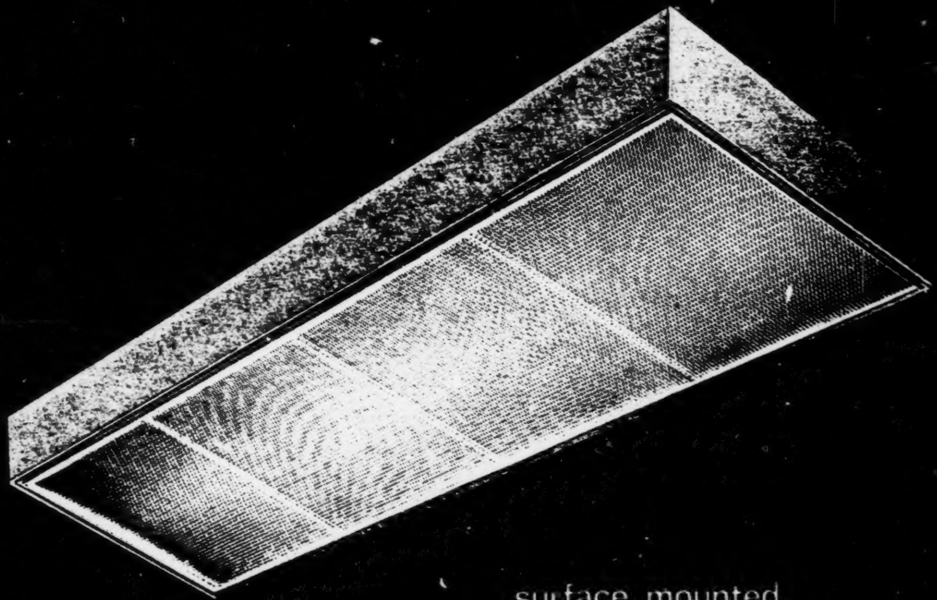
Terminal mounted, capacitor fuses complete with solderless connectors are supplied with each dustproof equipment. High speed interruption provides maximum protection. Positive screw type mounting simplifies connections. All capacitor fuses are HRC type having 100,000 amperes I.C.

Connections between the capacitor units of multiple dustproof equipment are completed with copper bus. Solderless phase connectors are provided for power connection.

⑥ Knockouts

Knockouts are provided on all sides of the terminal enclosure for conduit entrance.

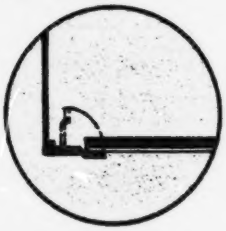
ELECTROLIER



surface mounted
en saillie

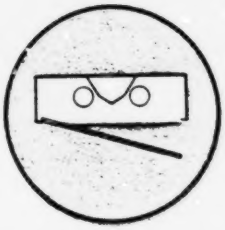
série "45" series

"LAY-IN" shielding supported on all four sides with captive "flip-up" trims on ends to facilitate insertion and removal of shielding.



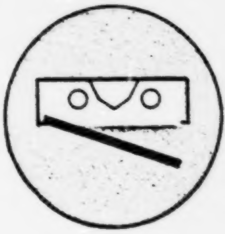
Diffuseur type déposé, supporté des 4 côtés avec garniture à bascule fixée sur la plaque de bout pour faciliter la mise en place du diffuseur.

Acrylic "hinged frameless LENS" injection moulded



LENTILLE à charnières sans cadre en acrylique moulée par injection.

"F" frame-die formed metal hinged lay-in doo supported on all four sides gasketted at ends to eliminate light leak.



Cadre en métal matrice déposé en forme de "F" supporté sur les 4 côtés e avec garniture aux bouts pour éliminer la perte de lumière.

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1′ x 4′ RAPID START / DÉMARRAGE RAPIDE

"LAY-IN" SHIELDING/DIFFUSEUR DÉPOSÉ		WITH "F" FRAME/AVEC CADRE "F"		ACRYLIC/ACRYLIQUE	
KHA-45-248	2 x 40 W	—	2 x 40 W	⊖Holophane No. 6160	HINGED FRAMELESS LENS LENTILLE À CHARNIÈRES SANS CADRE
KLA-45-248	"	**KLAF-45-248**	"	®Electrolens No. 2	
KEA-45-248	"	**KEAF-45-248**	"	®Electrolens No. 3	
K15A-45-248	"	**K15AF-45-248**	"	KSH K15	
K19A-45-248	"	**K19AF-45-248**	"	KSH K19	
K12A-45-248	"	**K12AF-45-248**	"	Prism Design No. 12 / Prismatique No 12	
KHH-45-248	"	**KHHF-45-248**	"	⊖Holophane No. 6150	
K6144-45-248	"	**K6144F-45-248**	"	⊖Holophane No. 6144	
KFP-45-248	"	—	"	Dropped Opal / Diffuseur opalin en saillie	
KLL-45-248	"	—	"	Small Cube Louver / Coupe-reflets à fins carreaux	
KLX-45-248	"	—	"	†Paraflex Parabolic Louver / Coupe-reflets parabolique	

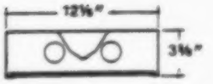
2′ x 2′ U-SHAPED LAMP RAPID START / LAMPE EN FORME DE U DÉMARRAGE RAPIDE

"LAY-IN" SHIELDING/DIFFUSEUR DÉPOSÉ		WITH "F" FRAME/AVEC CADRE "F"		ACRYLIC/ACRYLIQUE
KLA-45-248-U	2 x 40 W	**KLAF-45-248-U**	2 x 40 W	®Electrolens No. 2
KEA-45-248-U	"	**KEAF-45-248-U**	"	®Electrolens No. 3
K15A-45-248-U	"	**K15AF-45-248-U**	"	KSH K15
K19A-45-248-U	"	**K19AF-45-248-U**	"	KSH K19
K12A-45-248-U	"	**K12AF-45-248-U**	"	Prism Design No. 12 / Prismatique No 12
KHH-45-248-U	"	**KHHF-45-248-U**	"	⊖Holophane No. 6150
K6244-45-248-U	"	**K6244F-45-248-U**	"	⊖Holophane No. 6244
KFP-45-248-U	"	—	"	Dropped Opal / Diffuseur opalin en saillie
KLL-45-248-U	"	—	"	Small Cube Louver / Coupe-reflets à fins carreaux
KLX-45-248-U	"	—	"	†Paraflex Parabolic Louver / Coupe-reflets parabolique

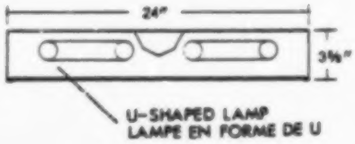
2′ x 4′ RAPID START / DÉMARRAGE RAPIDE

"LAY-IN" SHIELDING/DIFFUSEUR DÉPOSÉ		WITH "F" FRAME/AVEC CADRE "F"		ACRYLIC/ACRYLIQUE	
KHA-45-448	4 x 40 W	—	4 x 40 W	⊖Holophane No. 7260	HINGED FRAMELESS LENS LENTILLE À CHARNIÈRES SANS CADRE
KLA-45-448	"	**KLAF-45-448**	"	®Electrolens No. 2	
KEA-45-448	"	**KEAF-45-448**	"	®Electrolens No. 3	
K15A-45-448	"	**K15AF-45-448**	"	KSH K15	
K19A-45-448	"	**K19AF-45-448**	"	KSH K19	
K12A-45-448	"	**K12AF-45-448**	"	Prism Design No. 12 / Prismatique No 12	
KHH-45-448	"	**KHHF-45-448**	"	⊖Holophane No. 6150	
K6144-45-448	"	**K6144 F -45-448**	"	⊖Holophane No. 6244	
KFP-45-448	"	—	"	Dropped Opal / Diffuseur opalin en saillie	
KLL-45-448	"	—	"	Small Cube Louver / Coupe-reflets à fins carreaux	
KLX-45-448	"	—	"	†Paraflex Parabolic Louver / Coupe-reflets parabolique	

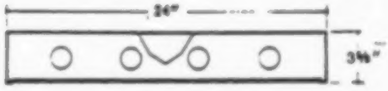
1′ x 4′



2′ x 2′



2′ x 4′

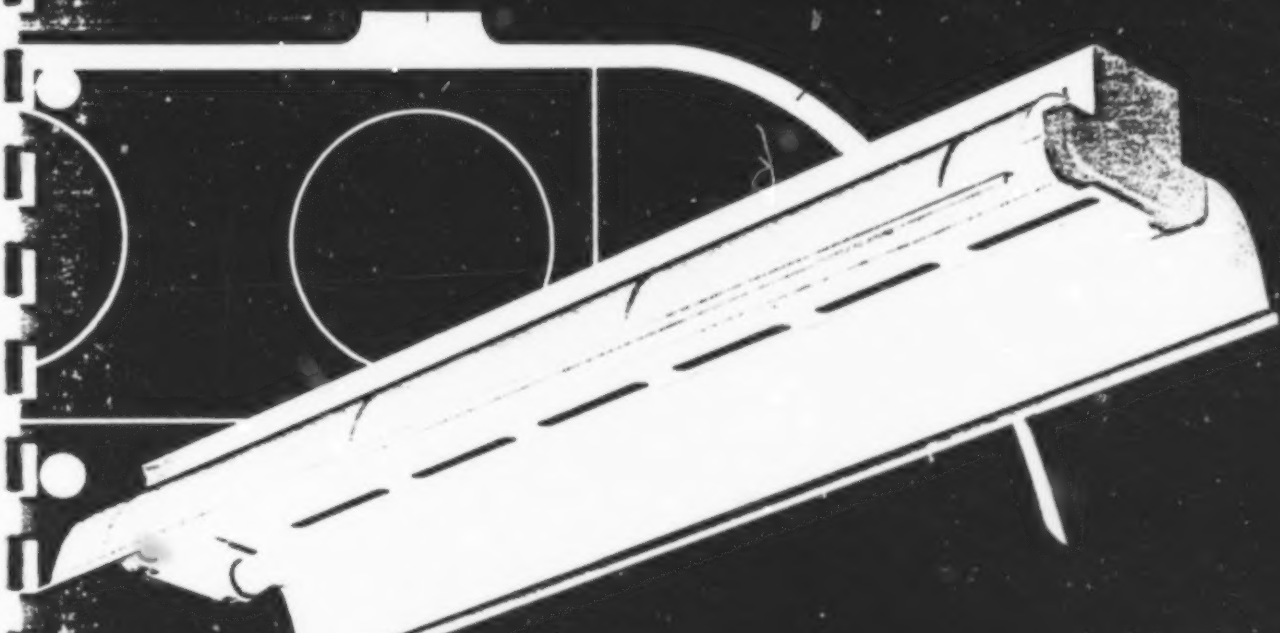


⊖ The Holophane Co. Ltd.
® Electroller Corporation

†Finish: Gold Metallized
Fini : métallisé or.

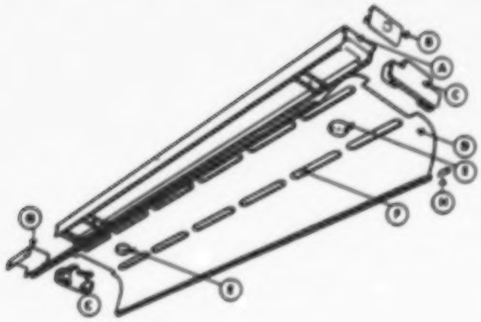
ELECTROLIER
CORPORATION

série " 72 " series



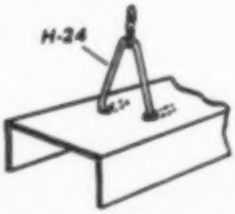
5 TWIN TURRET
DOUILLES JUMELLEES de 5"

série "72" series

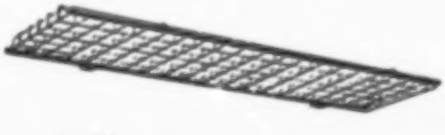


Ⓐ	WIRING CHANNEL	CANIVEAU DE CÂBLAGE
Ⓑ	CHANNEL END PLATE	PLAQUE DE BOUT
Ⓒ	TURRET TYPE SOCKETS	DOUILLES TYPE TURRET
Ⓓ	DIE-FORMED REFLECTOR	REFLECTEUR MATRICÉ
Ⓔ	CAPTIVE RELEASE	BOUCHON À DECLANCHEMENT
Ⓕ	EMBOSSED SLOTS	REFLECTEUR AJOURÉ
Ⓖ	JUNCTION STRAPS	BRIDE DE JONCTION
Ⓗ	ALIGNERS (2)	ALIGNEURS (2)

				RAPID START DEMARRAGE RAPIDE		SLIMLINE 430MA				RAPID START 800 MA DEMARRAGE RAPIDE 800 MA				V.H.O. 1500		
				120V	347V	120V	277V	347V	600V	120V	277V	347V	600V	120V	277V	34
BAKED WHITE ENAMEL "SOLID" REFLECTORS / REFLECTEURS PLEINS EN EMAIL CUIT, BLANC																
KT-72-248	2 x 40	4'	A	✓	✓											
KT-72-448-96	4 x 40	8'	B	✓	✓		TANDEM									
BAKED WHITE ENAMEL "SLOTTED" REFLECTORS / REFLECTEURS AJOURES EN EMAIL, CUIT, BLANC																
KTA-72-248	2 x 40	4'	A	✓	✓											
KTA-72-448-96	4 x 40	8'	B	✓	✓		TANDEM									
SLA-72-248	2 x 38	4'	C			✓	✓	✓	✓							
SLA-72-296	2 x 74	8'	D			✓	✓	✓	✓							
HA-72-248	2 x 60	4'	C							✓	✓	✓	✓			
HA-72-296	2 x 105	8'	D							✓	✓	✓	✓			
VA-72-248	2 x 107	4'	C											✓	✓	✓
VA-72-296	2 x 200	8'	D											✓	✓	✓
PORCELAIN ENAMEL "SLOTTED" REFLECTORS / REFLECTEURS AJOURES EN PORCELAINE EMAILLEE																
KTAP-72-248	2 x 40	4'	A	✓	✓											
KTAP-72-448-96	4 x 40	8'	B	✓	✓		TANDEM									
SLAP-72-296	2 x 74	8'	D			✓	✓	✓	✓							
HAP-72-296	2 x 105	8'	D							✓	✓	✓	✓			
VAP-72-296	2 x 200	8'	D											✓	✓	✓



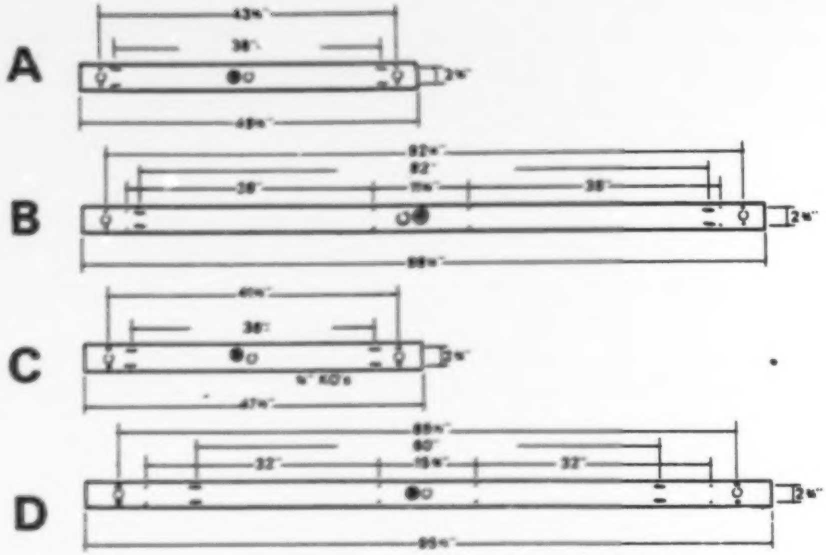
WIRE HANGER
CROCHET MÉTALLIQUE



ML-19
*ML-18 METAL LOUVER COUPE-REFLETS 45° x 30°

WIRE GUARD PROTECTEUR EN MÈCHE	WG-38 for/pour	KT-72-248
	WG-39 for/pour	SLA, HA, VA-72-248
	WG-41 for/pour	SLA, HA, VA-72-296

(2 required per 8' unit)
(2 requis pour unité de 8')


A
B
C
D
38"
82"
38"
38"
38"
80"
32"
32"
2¾"

LEGEND / LEGENDE

○ H-24 Mounting holes
Perforations pour montage H-24

● Surface mounting
Montage de surface

○ ⅞" KO
Débouchures de ⅞"

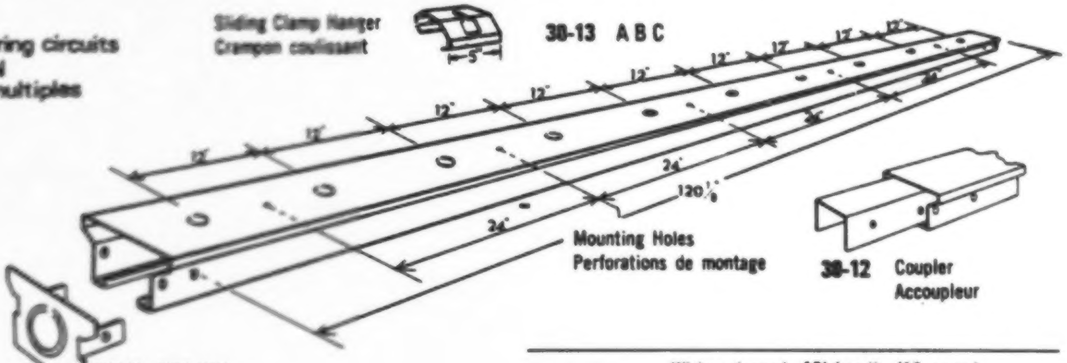
◎ Ground screw
Borne de mise à la terre

↔ Chain mounting slots
Encoches pour chaîne

No "30" WIRING CHANNEL / CANIVEAU

Finish: BAKED WHITE ENAMEL
Fini: ÉMAIL BLANC CUIT

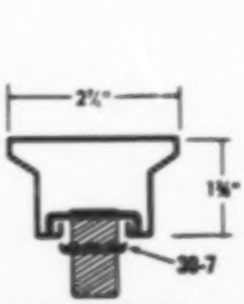
APPROVED
for multiple wiring circuits
APPROBATION
pour circuits multiples


Sliding Clamp Hanger
Crampon coulissant
5"
30-13 A B C
12"
24"
120⅛"
Mounting Holes
Perforations de montage
30-12 Coupler
Accoupleur
30-3 END CAP
COIFFE DE BOUT

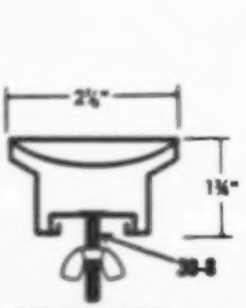
CH-30-10	Wiring channel 10' lengths (16 gauge) Caniveau de câblage long. de 10' (calibre 16)
CV-30-10	"PVC" cover — per 10' length Couvercle "P.V.C." — longueur de 10'
30-12	Coupler / Accoupleur
30-14	"I"-beam clamp Crampon pour poutre en "I"
30-13-A	Sliding hanger clamp (for H-11 hanger) Crampon coulissant (pour tige H-11)
30-13-B	Sliding hanger clamp (for ⅜" diameter rod) Crampon coulissant (pour tige de ⅜" de dia.)
30-13-C	Sliding hanger clamp (for ½" pipe - ⅞" dia.) Crampon coulissant (pour tige ½" - ⅞" dia.)
30-3	End cap / Coiffe de bout
30-7 *	"Feed-Thru" fixture fastening device Mécanisme de fixation "Feed-Thru"
30-8 *	Fixture fastening device Mécanisme de fixation

CV-30-10
EXTRUDED PVC
COVER SNAPS IN
LE COUVERCLE PVC
REFOULÉ S'AGRAFE
À L'INTÉRIEUR

30-14
I-BEAM CLAMP
CRAMPON POUR POUTRE EN "I"



"FEED-THRU" FIXTURE
FASTENING DEVICE
MÉCANISME DE FIXATION
"FEED-THRU"

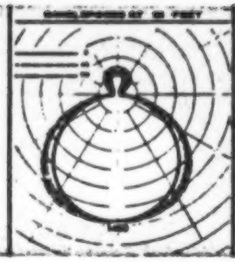


FIXTURE FASTENING
DEVICE
MÉCANISME DE
FIXATION D'APPAREIL

* 2 Req'd per 4' Fixture / 2 par appareil de 4'
3 Req'd per 8' Fixture / 3 par appareil de 8'

TA-72-248
2-40 Watt
CW

H.E.P.C.
Report
22366-RD



% FLOOR REFLECTANCE		10			10			10			10		
% CEILING REFLECTANCE		80			70			50			30		
% WALL REFLECTANCE		50	30	10	50	30	10	50	30	10	50	30	10
ROOM RATIO	ROOM INDEX	COEFFICIENTS OF UTILIZATION (X.01)											
0.6	J	31	28	22	30	26	22	30	25	22		25	22
0.8	I	40	34	30	39	34	30	38	33	30		33	30
1.0	H	47	41	37	47	41	37	46	40	37		39	36
1.25	G	56	49	44	54	48	44	52	47	43		46	43
1.5	F	60	54	49	59	53	49	57	52	48		51	47
2.0	E	67	61	57	66	60	56	63	59	55		57	54
2.5	D	72	66	62	70	65	61	67	63	60		61	58
3.0	C	75	70	66	73	69	65	70	67	64		64	62
4.0	B	79	75	71	77	74	70	74	71	68		68	66
5.0	A	82	79	76	80	77	74	77	74	72		72	70

BRIGHTNESS VALUES IN FOOTLAMBERTS

ZONE	TRANSVERSE MAX. VALUE	LONGITUDINAL MAX. VALUE
0-45	2545	2545
45-60	2545	2020
	2510	1870
60-75	2545	1530
75-90	980	1160

SHIELDING ANGLE* 12° —
*Measured from Horizontal.

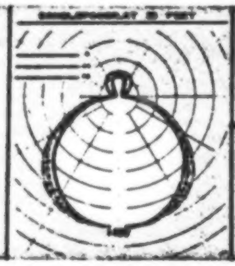
LUMINAIRE FLUX VALUES

ZONE	LUMENS	% TOTAL LAMP LUMENS	% TOTAL LUM. LUMENS
0 — 30°	1100	19.6	22.5
0 — 40°	1835	32.8	37.5
0 — 60°	3379	60.3	69.1
0 — 90°	4363	77.9	89.2
90 — 180°	527	9.4	10.8
0 — 180°	4890	87.3	100.0

TOTAL LAMP LUMENS 5600
LUMINAIRE EFFICIENCY 87.3
CIE CLASSIFICATION Semi-Direct

TAP-72-248
2-40 Watt
CW

H.E.P.C.
Report
22367-RD



% FLOOR REFLECTANCE		10			10			10			10		
% CEILING REFLECTANCE		80			70			50			30		
% WALL REFLECTANCE		50	30	10	50	30	10	50	30	10	50	30	10
ROOM RATIO	ROOM INDEX	COEFFICIENTS OF UTILIZATION (X.01)											
0.6	J	31	26	23	31	26	23	30	26	23		26	22
0.8	I	41	35	31	40	35	31	39	34	31		34	31
1.0	H	48	43	38	48	42	38	46	41	38		41	37
1.25	G	55	50	45	55	49	45	53	48	44		47	44
1.5	F	61	55	51	60	55	50	58	53	50		52	48
2.0	E	68	63	58	67	62	58	65	60	56		58	55
2.5	D	73	68	64	71	67	63	69	65	62		63	60
3.0	C	76	72	68	75	70	67	72	69	66		66	63
4.0	B	80	76	73	78	75	72	76	73	70		70	68
5.0	A	83	80	77	82	78	76	79	76	74		73	71

BRIGHTNESS VALUES IN FOOTLAMBERTS

ZONE	TRANSVERSE MAX. VALUE	LONGITUDINAL MAX. VALUE
0-45	2900	2885
45-60	2830	2020
	2575	1890
60-75	2520	1640
75-90	985	1160

SHIELDING ANGLE* 12° —
*Measured from Horizontal.

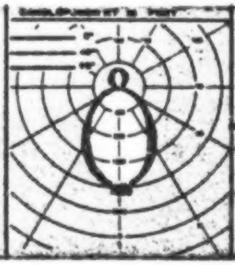
LUMINAIRE FLUX VALUES

ZONE	LUMENS	% TOTAL LAMP LUMENS	% TOTAL LUM. LUMENS
0 — 30°	1142	20.4	23.1
0 — 40°	1903	34.0	38.4
0 — 60°	3492	62.4	70.6
0 — 90°	4451	79.5	89.9
90 — 180°	499	8.9	10.1
0 — 180°	4950	88.4	100.0

TOTAL LAMP LUMENS 5600
LUMINAIRE EFFICIENCY 88.4
CIE CLASSIFICATION Semi-Direct

TA-72-248
2-40 Watt
CW
with ML-18
Louver

H.E.P.C.
Report
22371-RD



% FLOOR REFLECTANCE		10			10			10			10		
% CEILING REFLECTANCE		80			70			50			30		
% WALL REFLECTANCE		50	30	10	50	30	10	50	30	10	50	30	10
ROOM RATIO	ROOM INDEX	COEFFICIENTS OF UTILIZATION (X.01)											
0.6	J	25	22	20	25	22	20	25	22	20		22	19
0.8	I	33	29	26	32	28	26	31	28	25		27	25
1.0	H	38	33	30	37	33	30	36	32	30		31	29
1.25	G	42	38	35	42	38	35	40	37	35		35	33
1.5	F	46	42	39	45	41	38	43	40	37		38	36
2.0	E	51	47	44	50	46	43	47	44	42		42	40
2.5	D	54	50	47	52	49	46	50	47	45		45	43
3.0	C	56	53	50	54	51	49	52	49	47		47	46
4.0	B	59	56	53	57	55	52	54	52	50		50	48
5.0	A	61	58	56	59	57	55	56	54	53		51	50

BRIGHTNESS VALUES IN FOOTLAMBERTS

ZONE	TRANSVERSE MAX. VALUE	LONGITUDINAL MAX. VALUE
0-45	2080	2800
45-60	760	1280
	705	1085
60-75	400	880
75-90	390	820

SHIELDING 45°* X 30°*
*Louver shielding
Measured from Horizontal.

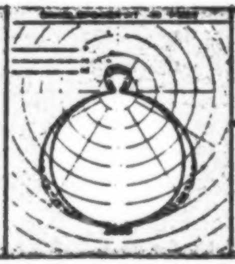
LUMINAIRE FLUX VALUES

ZONE	LUMENS	% TOTAL LAMP LUMENS	% TOTAL LUM. LUMENS
0 — 30°	1088	19.4	29.6
0 — 40°	1658	29.6	45.1
0 — 60°	2518	45.0	68.5
0 — 90°	3016	53.8	82.1
90 — 180°	656	11.8	17.9
0 — 180°	3673	65.6	100.0

TOTAL LAMP LUMENS 5600
LUMINAIRE EFFICIENCY 65.6
CIE CLASSIFICATION Semi-Direct

LA-72-296
-96 T-12

H.E.P.C.
Report
22368-RD



% FLOOR REFLECTANCE		10			10			10			10		
% CEILING REFLECTANCE		80			70			50			30		
% WALL REFLECTANCE		50	30	10	50	30	10	50	30	10	50	30	10
ROOM RATIO	ROOM INDEX	COEFFICIENTS OF UTILIZATION (X.01)											
0.6	J	31	28	23	31	26	23	30	26	22		25	22
0.8	I	41	35	31	40	35	31	38	34	30		34	30
1.0	H	48	42	38	47	42	38	46	41	37		40	37
1.25	G	55	49	45	55	48	45	53	48	44		47	43
1.5	F	61	55	50	60	54	50	58	53	49		52	48
2.0	E	68	62	58	67	62	57	64	60	56		58	56
2.5	D	73	68	63	71	66	63	68	64	61		62	60
3.0	C	76	71	67	74	70	66	72	68	66		66	63
4.0	B	80	76	73	79	75	72	76	72	70		70	68
5.0	A	83	80	77	82	78	76	78	76	73		73	71

BRIGHTNESS VALUES IN FOOTLAMBERTS

ZONE	TRANSVERSE MAX. VALUE	LONGITUDINAL MAX. VALUE
0-45	2700	2700
45-60	2745	2080
	2720	1835
60-75	2745	1560
75-90	1295	1220

SHIELDING ANGLE* 12° —
*Measured from Horizontal.

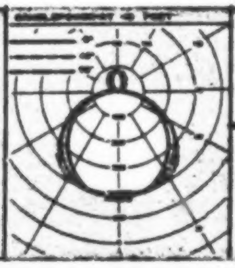
LUMINAIRE FLUX VALUES

ZONE	LUMENS	% TOTAL LAMP LUMENS	% TOTAL LUM. LUMENS
0 — 30°	2310	20.0	22.5
0 — 40°	3876	33.4	37.7
0 — 60°	7196	61.7	69.6
0 — 90°	9205	79.4	89.5
90 — 180°	1080	9.3	10.5
0 — 180°	10285	88.7	100.0

TOTAL LAMP LUMENS 11,600
LUMINAIRE EFFICIENCY 88.7
CIE CLASSIFICATION Semi-Direct

A-72-296
-96 T-12

H.E.P.C.
Report
22369-RD



% FLOOR REFLECTANCE		10			10			10			10		
% CEILING REFLECTANCE		80			70			50			30		
% WALL REFLECTANCE		50	30	10	50	30	10	50	30	10	50	30	10
ROOM RATIO	ROOM INDEX	COEFFICIENTS OF UTILIZATION (X.01)											
0.6	J	30	26	21	29	25	21	29	24	21		24	21
0.8	I	39	33	30	38	33	29	37	33	29		32	29
1.0	H	46	40	36	46	40	36	44	39	35		38	35
1.25	G	53	47	43	52	47	43	50	46	42		44	41
1.5	F	58	52	48	57	52	48	56	50	47		49	46
2.0	E	65	59	56	64	59	56	61	57	53		56	52
2.5	D	69	64	60	69	63	60	65	61	58		59	57
3.0	C	72	68	64	71	67	63	68	66	62		62	60
4.0	B	76	73	69	75	71	68	72	69	66		66	65
5.0	A	79	76	73	78	76	72	74	72	70		69	68

BRIGHTNESS VALUES IN FOOTLAMBERTS

ZONE	TRANSVERSE MAX. VALUE	LONGITUDINAL MAX. VALUE
0-45	4180	4180
45-60	4350	3220
	4210	2995
60-75	4290	2410
75-90	1965	1900

SHIELDING ANGLE* 12° —
*Measured from Horizontal.

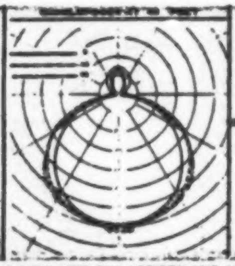
LUMINAIRE FLUX VALUES

ZONE	LUMENS	% TOTAL LAMP LUMENS	% TOTAL LUM. LUMENS
0 — 30°	3386	19.0	22.5
0 — 40°	5664	31.8	37.7
0 — 60°	10451	58.7	69.6
0 — 90°	13446	75.5	89.5
90 — 180°	1578	8.8	10.5
0 — 180°	15023	84.4	100.0

TOTAL LAMP LUMENS 17,800
LUMINAIRE EFFICIENCY 84.4
CIE CLASSIFICATION Semi-Direct

A-72-296
-96 T-12

H.E.P.C.
Report
22370-RD



% FLOOR REFLECTANCE		10			10			10			10		
% CEILING REFLECTANCE		80			70			50			30		
% WALL REFLECTANCE		50	30	10	50	30	10	50	30	10	50	30	10
ROOM RATIO	ROOM INDEX	COEFFICIENTS OF UTILIZATION (X.01)											
0.6	J	29	24	21	29	24	21	28	24	21		23	20
0.8	I	38	32	29	37	32	29	36	32	28		31	28
1.0	H	45	39	36	44	39	35	43	38	35		37	34
1.25	G	52	46	42	51	46	42	49	44	41		43	40
1.5	F	57	51	47	56	50	46	54	49	45		48	45
2.0	E	63	58	54	62	57	53	60	56	52		54	51
2.5	D	68	62	59	66	62	58	63	60	57		58	55
3.0	C	71	66	63	69	66	62	66	63	60		61	59
4.0	B	74	71	67	73	70	67	70	67	65		65	63
5.0	A	77	74	71	76	73	70	72	70	68		68	66

BRIGHTNESS VALUES IN FOOTLAMBERTS

ZONE	TRANSVERSE MAX. VALUE	LONGITUDINAL MAX. VALUE
0-45	7250	7250
45-60	7370	5565
	7200	5200
60-75	7370	4190
75-90	3240	3300

SHIELDING ANGLE* 12° —
*Measured from Horizontal.

LUMINAIRE FLUX VALUES

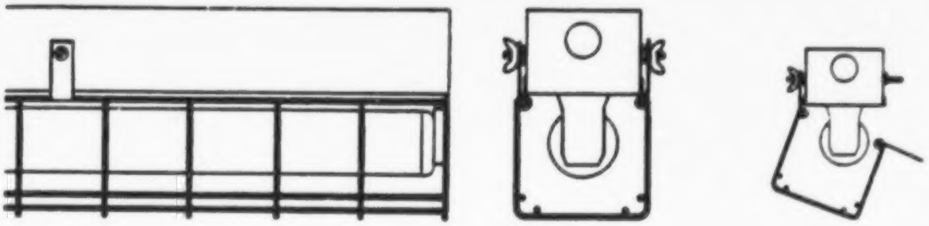
ZONE	LUMENS	% TOTAL LAMP LUMENS	% TOTAL LUM. LUMENS
0 — 30°	5660	18.5	22.5
0 — 40°	9300	31.0	37.7
0 — 60°	17161	57.2	69.6
0 — 90°	22079	73.6	89.5
90 — 180°	2592	8.6	10.5
0 — 180°	24671	82.2	100.0

TOTAL LAMP LUMENS 30,000
LUMINAIRE EFFICIENCY 82.2
CIE CLASSIFICATION Semi-Direct

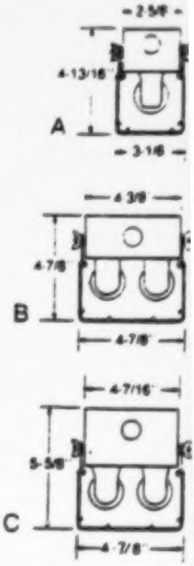
(1) CALCULATED BY HARRISON AND ANDERSON METHOD
(2) CALCULATED BY ZONAL INTERREFLECTANCE METHOD

SYLVANIA **GTE**

WG-401/402 series

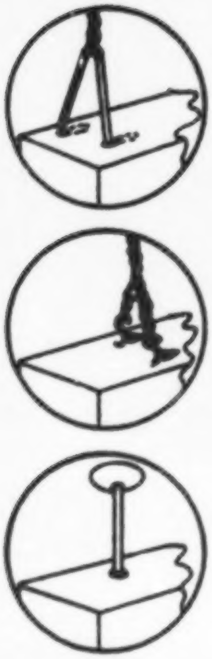


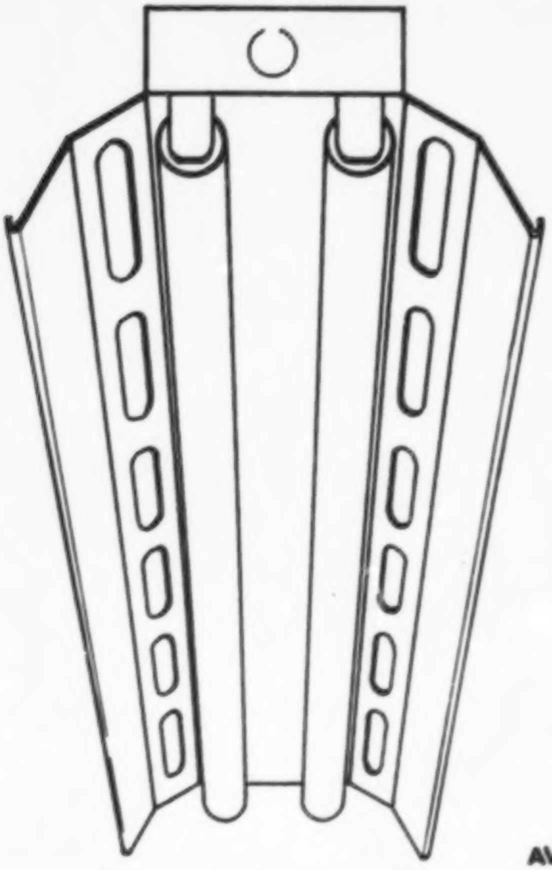
H-24 WIRE HANGER

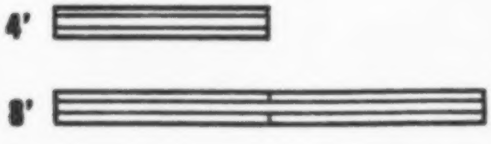

2-5/8
4-13/16"
A
3-1/8
4-3/8
4-7/8"
B
4-7/8"
4-7/16"
5-5/8"
C
4-7/8"

				10°C/50°F		−18°C/0°F		−29°C/−20°F	
RAPID START				120V	347V	120V	347V	120V	347V
KWG-401-148	1 x 40	4′	A	√	√	√	√	—	—
KWG-401-248-96	2 x 40	8′	A	√	√	√	√	—	—
KWG-402-248	2 x 40	4′	B	√	√	√	√	—	—
KWG-402-448-96	4 x 40	8′	B	√	√	√	√	—	—
SLIMLINE 430 MA				—	—	—	—	—	—
SLWG-402-296	2 x 74	8′	B	√	√	√	—	—	—
RAPID START 800 MA				—	—	—	—	—	—
HWG-402-296	2 x 105	8′	C	√	√	√	√	√	√

STANDARD INDUSTRIALS/APPAREIL INDUSTRIEL TYPE COURANT







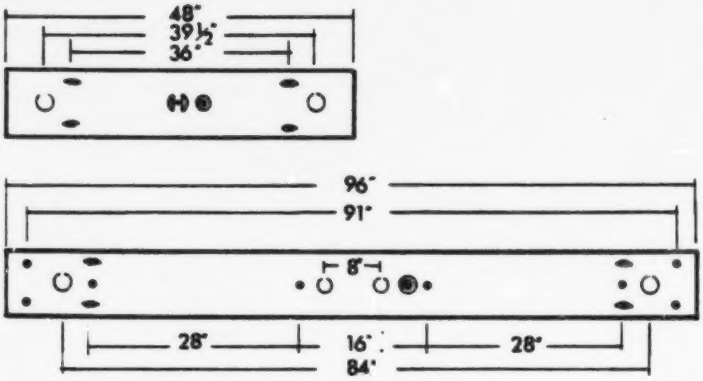
AVAILABLE LIGHT SOURCES/ SOURCES LUMINEUSES UTILISABLES

- 1500 MA PG or ou VHO
- 800 MA HO
- 430 MA SLIMLINE
- RAPID START DÉMARRAGE RAPIDE

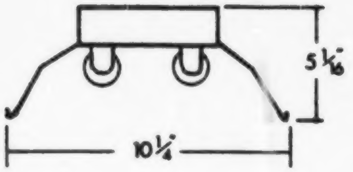
ELECTROLIER
GTE SYLVANIA

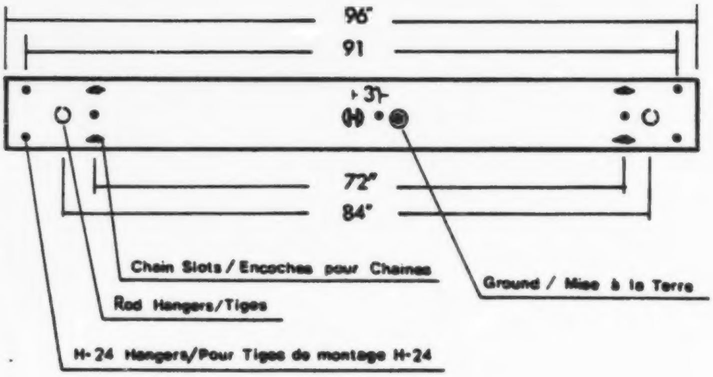
SÉRIE "138" SERIES

plan view/ vue de plan

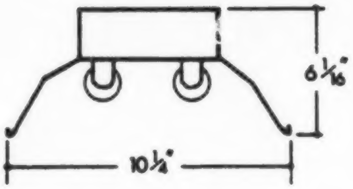

48"
39½"
36"
96"
91"
8"
28"
16"
28"
84"

Cross section




96"
91
3"
72"
84"
Chain Slots / Encoches pour Chaines
Ground / Mise à la Terre
Rod Hangers/Tiges
H-24 Hangers/Pour Tiges de montage H-24

Cross section



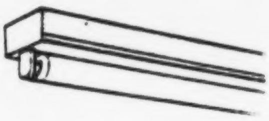
			RAPID START DÉMARRAGE RAPIDE		SLIMLINE 430 MA				RAPID START 800 MA DÉMARRAGE RAPIDE 800 MA				P.G.-V.H.O. 1500 MA			
			120V	347V	120V	277V	347V	600V	120V	277V	347V	600V	120V	277V	347V	600V
BAKED WHITE ENAMEL "SOLID" REFLECTORS/RÉFLECTEURS PLEINS EN ÉMAIL CUIT, BLANC																
K-138-248	2 x 40	4'	✓	✓	—	—	—	—	—	—	—	—	—	—	—	—
K-138-448-96	4 x 40	8'	✓	✓	—	—	—	—	—	—	—	—	—	—	—	—
SL-138-296	2 x 74	8'	—	—	✓	✓	✓	✓	—	—	—	—	—	—	—	—
H-138-296	2 x 105	8'	—	—	—	—	—	—	✓	✓	✓	✓	—	—	—	—
P-138-296	2 x 200	8'	—	—	—	—	—	—	—	—	—	—	✓	✓	✓	✓

BAKED WHITE ENAMEL "SLOTTED" REFLECTORS/RÉFLECTEURS AJOURÉS EN ÉMAIL, CUIT, BLANC																
KA-138-248	2 x 40	4'	✓	✓	—	—	—	—	—	—	—	—	—	—	—	—
KA-138-448-96	4 x 40	8'	✓	✓	—	—	—	—	—	—	—	—	—	—	—	—
SLA-138-296	2 x 74	8'	—	—	✓	✓	✓	✓	—	—	—	—	—	—	—	—
HA-138-296	2 x 105	8'	—	—	—	—	—	—	✓	✓	✓	✓	—	—	—	—
PA-138-296	2 x 200	8'	—	—	—	—	—	—	—	—	—	—	✓	✓	✓	✓

SYLVANIA GTE

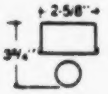
Strip-Lights series

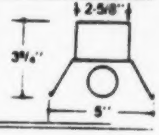
RAPID START

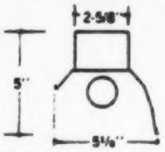


401

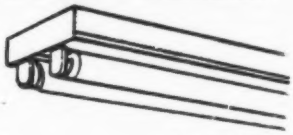
			HPF	10°C/50°F 120V	10°C/50°F 347V	−18°C/0°F 120V	−18°C/0°F 347V
K-401-124	1 x 20	2′	✓	✓	✓	—	—
K-401-136	1 x 30	3′	✓	✓	✓	✓	✓
K-401-148	1 x 40	4′	✓	✓	✓	✓	✓
K-401-248-96	2 x 40	8′	✓	✓	✓	✓	✓
K-401-A-148	1 x 40	4′	✓	✓	✓	✓	✓
K-401-A-248-96	2 x 40	8′	✓	✓	✓	✓	✓
K-401-B-148	1 x 40	4′	✓	✓	✓	✓	✓
K-401-B-248-96	2 x 40	8′	✓	✓	✓	✓	✓



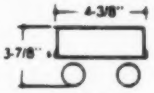


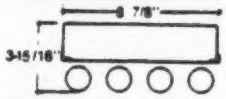


402 / 404



K-402-224	2 x 20	2′	✓	✓	✓	—	—
K-402-248	2 x 40	4′	✓	✓	✓	✓	✓
K-402-448-96	4 x 40	8′	✓	✓	✓	✓	✓
K-404-448	4 x 40	4′	✓	✓	✓	✓	✓

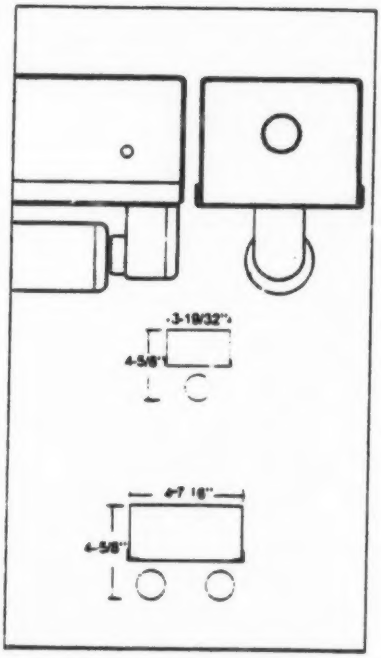




401/402 SERIES

SLIMLINE • H.O.

CAT. NO.			10°C/50°F 120V	10°C/50°F 347V	−18°C/0°F 120V	−18°C/0°F 347V	−29°C/−20°F 120V	−29°C/−20°F 347V
SLIMLINE 425 mA								
SL-401-148	1 x 38	4′	✓	—	✓	—	—	—
L-402-248	2 x 38	4′	✓	✓	✓	—	—	—
L-401-196	1 x 74	8′	✓	✓	✓	—	—	—
L-402-296	2 x 74	8′	✓	✓	✓	—	—	—
L-401-296-192	2 x 74	16′	✓	✓	✓	—	—	—
APID START 800 mA								
-401-148	1 x 60	4′	✓	✓	—	—	✓	✓
-402-248	2 x 60	4′	✓	✓	—	—	✓	✓
-401-196	1 x 105	8′	✓	✓	—	—	✓	✓
-402-296	2 x 105	8′	✓	✓	—	—	✓	✓
-401-296-192	2 x 105	16′	✓	✓	—	—	✓	✓



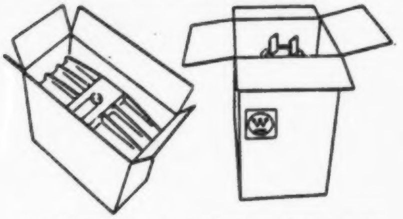
Flexoliner

Application

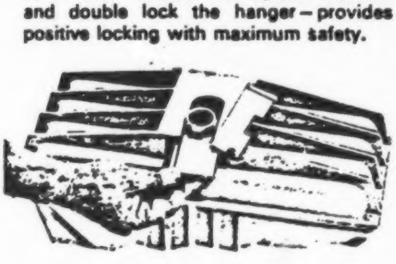
The Flexoliner is designed to deliver maximum light to the work area from high mounting (80′) down to low mounting (15′), and for use where durability and minimum maintenance are also prime considerations.

Features – Benefits

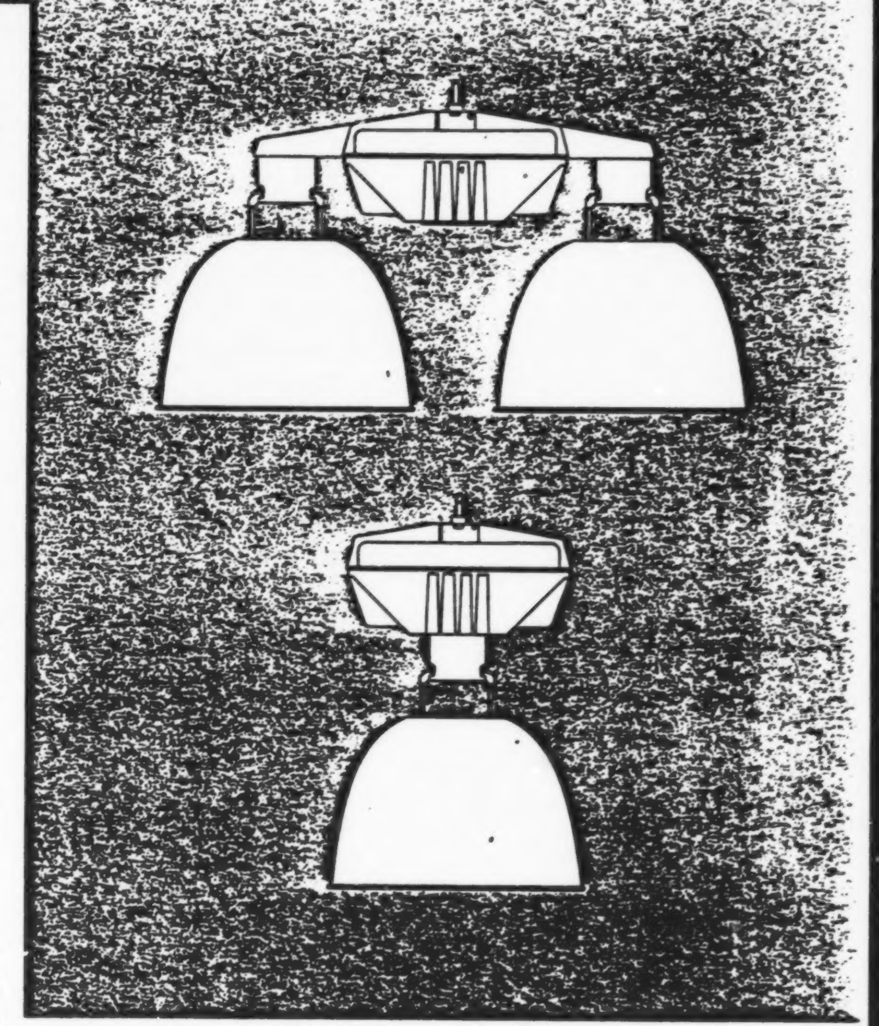
- Coordinated construction and shipment packages – complete optical and electrical elements are supplied separate for ease of handling and convenient installation.



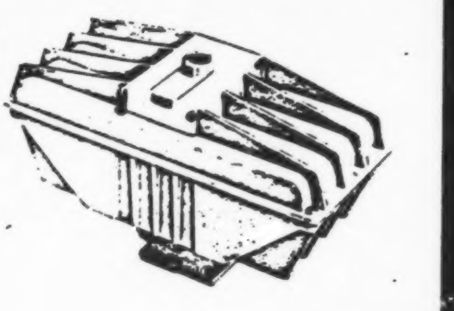
- "Quickie" hanger (with slide-lock attachment). Thread hanger to conduit feed, lock with set screw, ballast housing slides on and locks in. After wiring, rotate the cover door to close the splice chamber and double lock the hanger – provides positive locking with maximum safety.

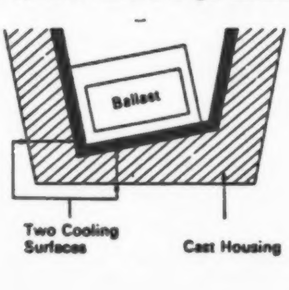


- Adjustable light center position – Flex-Loc® reflector fitter easily moved to any one of eleven positions (without handling loose parts or tools); provides quick light center adjustment for the desired distribution pattern before, during or after installation.

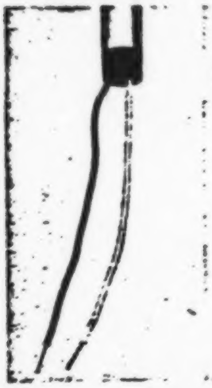


- Dual Cooling System – finned ballast housing acts as a heatsink for ballast core and coil, dissipates heat quickly, positive contact on two sides give maximum conduction. Heat baffle isolates capacitors – cooler operation means longer ballast life.

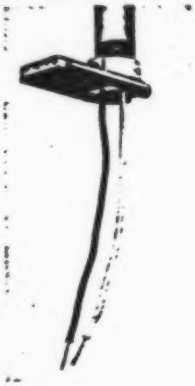




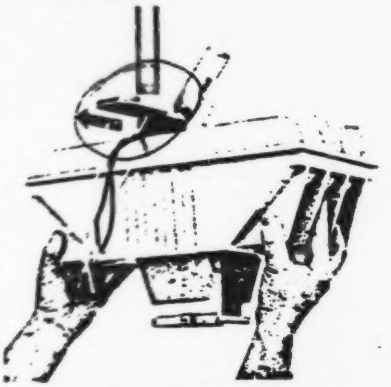
1. Conduit with leads prepared to receive luminaire



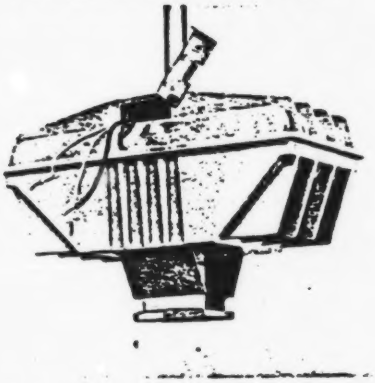
2. Quickie hanger threaded onto conduit and locked with set screw



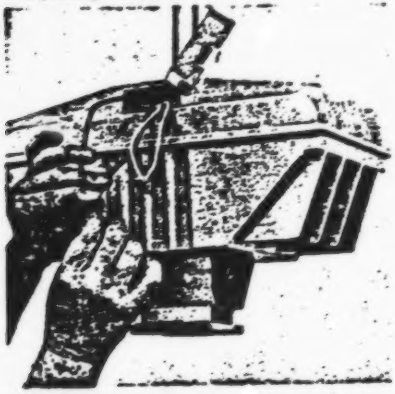
3. Ballast housing slides onto hanger and locks in position



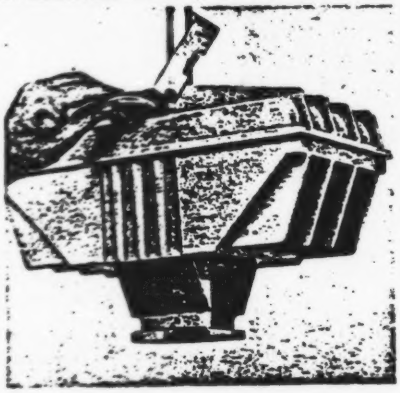
4. Wiring leads exposed for splicing



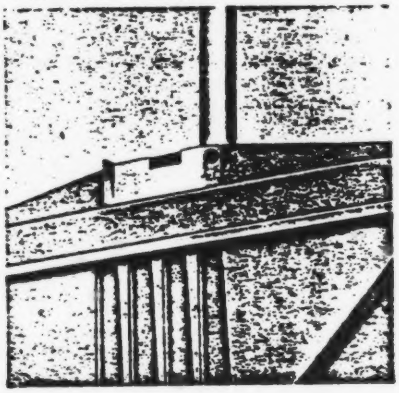
5. Splicing completed



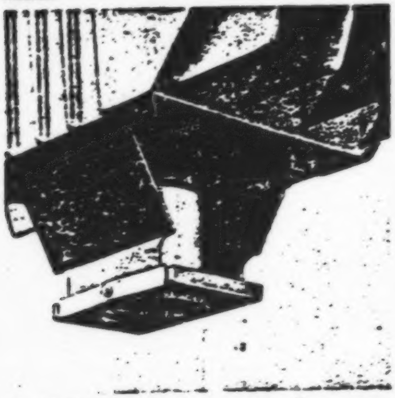
6. Leads returned to splice chamber



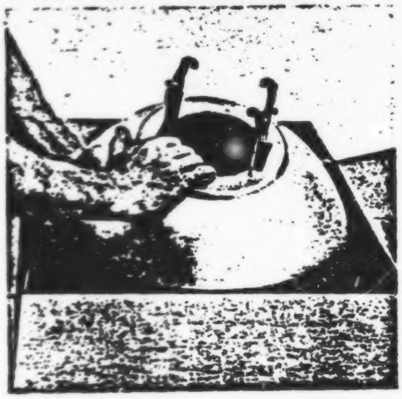
7. Rotate chamber cover into position



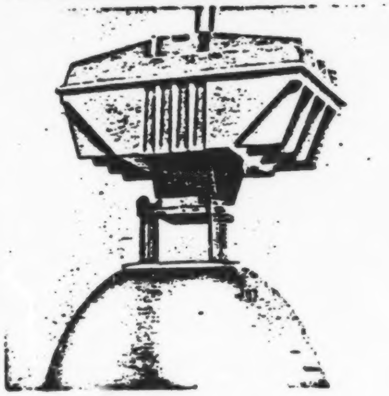
8. Ballast housing prepared to receive reflector



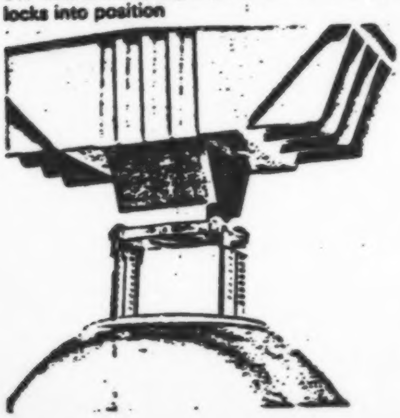
9. Remove reflector from carton



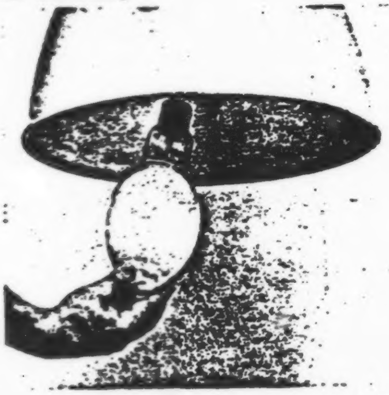
10. Slide flex-loc fitter into position



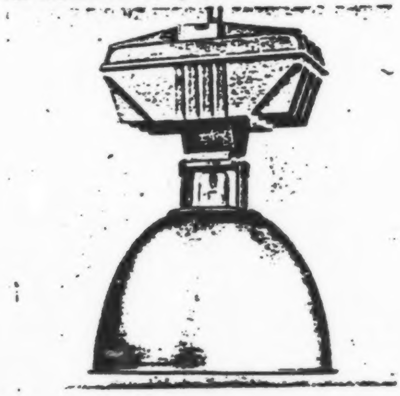
11. Withdraw spring clips and reflector snap locks into position



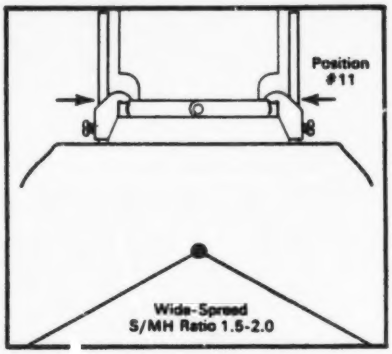
12. Insert lamp

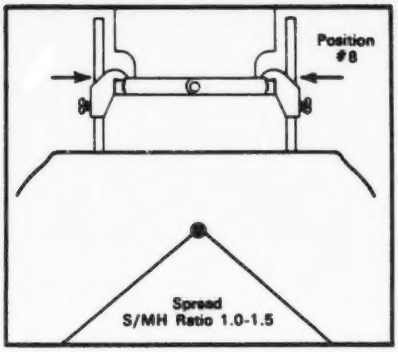


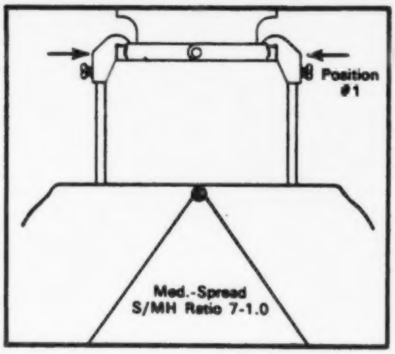
13. Installation complete



The following information is provided to guide the selection of the proper Flex-loc reflector setting on the job site.


Position
#11
Wide-Spread
S/MH Ratio 1.5-2.0


Position
#8
Spread
S/MH Ratio 1.0-1.5


Position
#1
Med.-Spread
S/MH Ratio 7-1.0

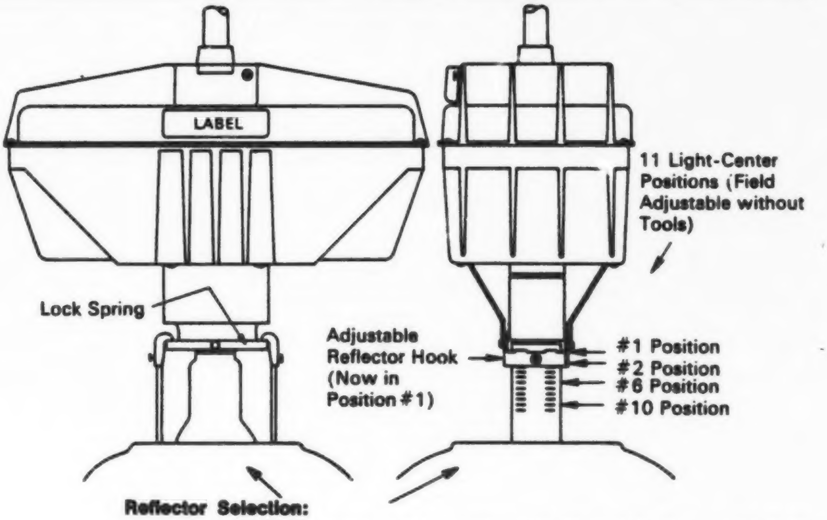
Flex-loc Reflector Settings—

Positions 1 through 11.

Plus selected Reflector size and finish.

Plus H.I.D. Lamp; Mercury, Metal Halite, or Ceramalux.

Combinations of the above variables provide a full range of photometric performance to meet any requirement.

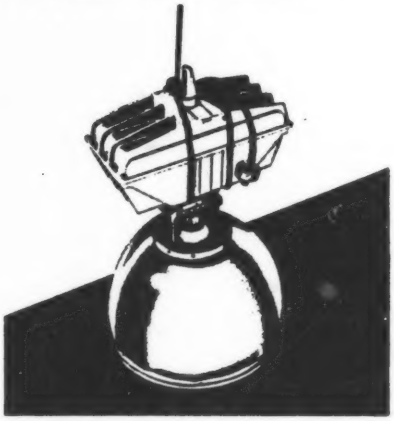

LABEL
Lock Spring
Adjustable
Reflector Hook
(Now in
Position #1)
11 Light-Center
Positions (Field
Adjustable without
Tools)
#1 Position
#2 Position
#6 Position
#10 Position

Reflector Selection:

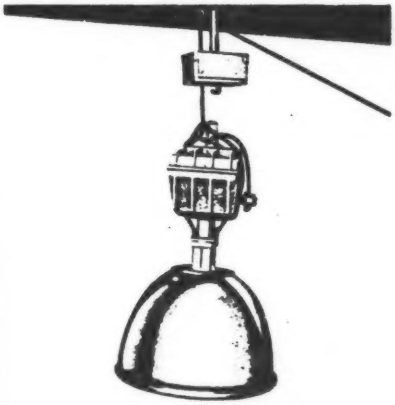
Aluminum 18" Diam. Type A-18
Aluminum 22" Diam. Type A-22
Prismatic Glass 15" Diam. Type G-15
Prismatic Glass 21" Diam. Type G-21

Alternate Installation Procedures

Assemble luminaire complete at ground level and prepare to hoist to ceiling location.



Hoist to previously installed Du-All Hanger for attachment and plug-in.



Installation complete (Hooks and receptacles independently installed by the customer may be used in place of the Du-All Hanger).

Dimensions in Inches	Single 18" Reflector	Single 22½" Reflector	Tandem 18" Reflector	Tandem 22½" Reflector
Length—Top of Unit	16	16	27¼	27¼
Width—Top of Unit	7⅝	7⅝	7⅝	7⅝
Length—Bottom of Unit	18	24	41	46
Height	28¼	27¾	22¼	23¼

LUMINAIRES — High and Low Bay
Flexoliner

Specifications

Ballast Housing – Cast aluminum; lightweight, non-corrosive material finished with baked gray enamel (ASA-70) for high thermal emissivity. Suitability for either 400W or 1000W ballasts. With the extended top casting, two 400W systems may be operated in tandem. The top castings overlap the bottom casting to prevent entry of moisture or other contaminants. The junction is made secure with four (4) #10 vibration-resistant screws.

Ballasts – A full selection of ballast types is available. The standard design is the "Auto-Reg" (±10V to ±5W) type with capacitors for high power factor (over 90% operation). The ballast is approved for 55°C (131°F.) ambient areas. Ballasts for 65°C ambients are also available.

Socket Assembly – The porcelain-enclosed socket is rated for 600V operation. It is equipped with lamp grips for positive acceptance of the mercury lamp electrically and mechanically. The surrounding shroud provides protection for the socket and redirects lamp heat away from the ballast.

Reflector Assembly – The reflector is spun aluminum and finished by the Alzak process. The chemically brightened aluminum is covered with a "glass-like" oxide coating which resists dirt build-up and provides an easy-to-clean and easy-to-handle assembly. Aluminum reflectors with prismatic glass inner reflectors are also available.

The Flex-loc® fitter is solidly attached to the reflector beneath a heavy duty support ring. The ring is riveted permanently into position. All formed metal parts are steel-zinc plated – for long life and continuing adjustability.

Type Number Key:
Complete Luminaires
(with integral ballasts)
Example: FM-A184-120

F	M	A	18	4	120
(1)	(2)	(3)	4)	(5)	(6)

(1) F = Flexoliner U = Uniliner
(2) M = Mercury H = Metal Halide
(C = Ceramalux) E = Enclosed
(3) A = Alzak Aluminum Reflector
G = Glass Reflector
GL = Glass Laminated
(4) 15 = 15" Dia. (Reflector) 18 = 18" Dia.
21 = 21 = 21" Dia. 22 = 22½" Dia.
(5) 1 = 175 watt[1]
2 = 250 watt[1]
4 = 400 watt
8 = twin 400 watt
0 = 1000 watt
(6) 120 = volts 208, 240, 277, 347, 480, and 600 alternate voltages

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Specification Summary:
An integral ballasted H.I.D. luminaire including: The reflector is attached to the ballast housing with a flexible-locking-assembly which permits easy adjustment of the light center over a 2" range developing a selection of distributions. The ventilated aluminum reflector has an alzak finish developed to a thickness of 7.5 Mg/Sq. in. The ballast housing is cast aluminum finished with ASA 70 high emissivity gray baked enamel and finned for maximum heat sinking from direct contact with the ballast core on two sides and rated for 55°C environments. The luminaire assembly slide-locks onto a hanger fitting pre-attached to ¾" conduit. The spring loaded wiring chamber cover door double locks the fitting in position. No tools required or loose parts to handle.

ORDERING INFORMATION — ORDER BY TYPE NUMBER
AVAILABLE IN 120/208/240/277/347/480/600 VOLTS.

Flexoliner with SEMI-SPECULAR Alzak Aluminum Reflectors

Description	Volts	Type Number
Standard Mercury		
Single, 400 Watt 18" A-18 Reflector Ship. Wt. 26 lbs.	120 208 240 277 347 480 600	FM-A184-120 FM-A184-208 FM-A184-240 FM-A184-277 FM-A184-347 FM-A184-480 FM-A184-600
Single, 400 Watt 22½" A22 Reflector Ship. Wt. 29 lbs.		FM-A224-voltage
Tandem, 400 Watt 18" A-18 Reflector Ship. Wt. 43 lbs.		FM-A188-voltage
Tandem, 400 Watt 22½" A-22 Reflector Shipping Wt. 51 lbs.		FM-A228-voltage
Single, 1000 Watt 22½" A-22 Reflector Ship. Wt. 38 lbs.		FM-A220-voltage
Metal Halide		
Single, 400 Watt 18" A-18 Reflector Ship. Wt. 29 lbs.		FH-A184-voltage
Single, 1000 Watt 22½" A-22 Reflector Ship. Wt. 32 lbs.		FH-A220-voltage
Ceramalux		
Single, 400 Watt 18" A-18 Reflector Ship. Wt. 29 lbs.		FC-A184-voltage
Single, 1000 Watt 22½" A-22 Reflector Ship. Wt. 42 lbs.		FC-A220-voltage

Flexoliner with PRISMATIC GLASS Reflectors

Description	Volts	Type Number
Standard Mercury		
Single, 400 Watt 15" G-15 Reflector Ship. Wt. 42 lbs.	120 208 240 277 347 480 600	FM-G154-120 FM-G154-208 FM-G154-240 FM-G154-277 FM-G154-347 FM-G154-480 FM-G154-600
Single, 400 Watt 21" G-21 Reflector Ship. Wt. 57 lbs.		FM-G214-voltage
Tandem, 400 Watt 15" G-15 Reflector Ship. Wt. 77 lbs.		FM-G158-voltage
Tandem, 400 Watt 21" G-21 Reflector Ship. Wt. 107 lbs.		FM-G218-voltage
Single, 1000 Watt 21" G-21 Reflector Ship. Wt. 66 lbs.		FM-G214-voltage
Metal Halide		
Single, 400 Watt 15" G-15 Reflector Ship. Wt. 46 lbs.		FH-G154-voltage
Single, 1000 Watt 21" G-21 Reflector Ship. Wt. 70 lbs.		FH-G210-voltage
Ceramalux		
Single, 400 Watt 15" G-15 Reflector Ship. Wt. 46 lbs.		FC-G154-voltage
Single, 1000 Watt 21" G-21 Reflector Ship. Wt. 70 lbs.		FC-A210-voltage

Flexoliner with GLASS LAMINATED Reflectors

Description	Volts	Type Number
Standard Mercury		
Single 400 Watt 18" GL-18 Reflector Ship. Wt. 27 lbs.	120 208 240 277 347 480 600	FM-GL184-120 FM-GL184-208 FM-GL184-240 FM-GL184-277 FM-GL184-347 FM-GL184-480 FM-GL184-600
Single, 400 Watt 22½" GL-22 Reflector Ship. Wt. 30 lbs.		FM-GL224-voltage
Tandem, 400 Watt 18" GL-18 Reflector Ship. Wt. 47 lbs.		FM-GL188-voltage
Tandem, 400 Watt 22½" GL-22 Reflector Ship. Wt. 53 lbs.		FM-GL228-voltage
Single 1000 Watt 22½" GL-22 Reflector Ship. Wt. 38 lbs.		FM-GL220-voltage
Metal Halide		
Single, 400 Watt 18" GL-18 Reflector Ship. Wt. 30 lbs.		FH-GL184-voltage
Single, 1000 Watt 22½" GL-22 Reflector Ship. Wt. 43 lbs.		FH-GL220-voltage
Ceramalux		
Single 400 Watt 18" GL-18 Reflector Ship. Wt. 30 lbs.		FC-GL184-voltage
Single, 1000 Watt 22½" GL-22 Reflector Ship. Wt. 43 lbs.		FC-GL220-voltage

Flexoliner with ENCLOSED ALZAK Reflectors

Description	Volts	Type Number
Standard Mercury		
Single 400 Watt 18" EA-18 Reflector Ship. Wt. 28½ lbs.	120 208 240 277 347 480 600	FM-EA184-120 FM-EA184-208 FM-EA184-240 FM-EA184-277 FM-EA184-347 FM-EA184-480 FM-EA184-600
Single, 400 Watt 22½ EA-22 Reflector Ship. Wt. 31½ lbs.		FM-EA224-voltage
Tandem, 400 Watt 18" EA-18 Reflector Ship. Wt. 50 lbs.		FM-EA188-voltage
Tandem 400 Watt 22½" EA-22 Reflector Ship. Wt. 58 lbs.		FM-EA228-voltage
Single, 1000 Watt 22½" EA-22 Reflector Ship. Wt. 40½ lbs.		FM-EA220-voltage
Metal Halide		
Single, 400 Watt 18" EA-18 Reflector Ship. Wt. 31½ lbs.		FH-EA184-voltage
Single 1000 Watt 22½ EA-22 Reflector Ship. Wt. 44½ lbs.		FH-EA220-voltage
Ceramalux		
Single, 400 Watt 18" EA-18 Reflector Ship. Wt. 31½ lbs.		FC-EA184-voltage
Single, 1000 Watt 22½" EA-22 Reflector Ship. Wt. 44½ lbs.		FC-EA220-voltage